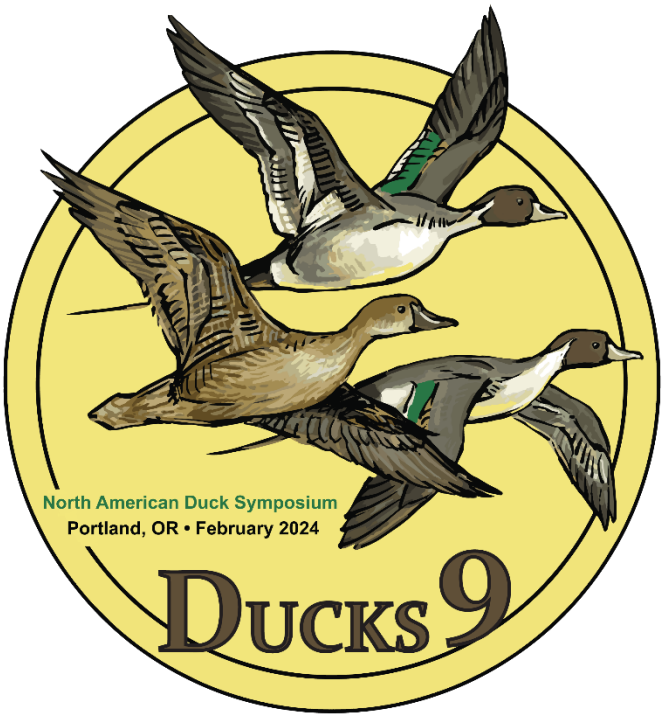
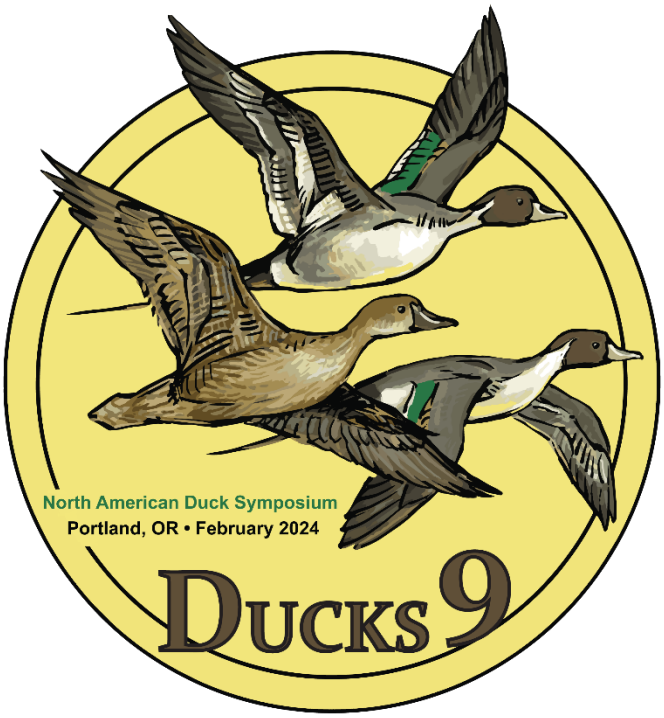
Presentation and Poster Abstracts



Presentation Abstracts



Straddling Fences: Birds, Behavior, Plans, and People

Presented by: John Eadie (jmeadie@ucdavis.edu)

J. Eadie, Department of Wildlife, Fish, and Conservation Biology, University of California, Davis

Al Afton and his cohort of fellow graduate students and young research scientists changed the world. For me. They pushed the boundaries by not only doing great research on waterfowl and wetlands, but also by explicitly incorporating contemporary ecological theory into their studies, complete with rigorous hypothesis testing, experimental field studies, and exhaustive field work. And they never lost sight on the need to ensure that their research was management relevant. It was a heady period in waterfowl ecology. As a fledging undergraduate, Al and his colleagues established a framework that has shaped my entire career, and I hope to use this presentation to illustrate their influence with some of my own work. In the first section of my talk, I describe two projects where we have attempted to staddle that fence between theory and application. I was trained as a behavioral ecologist and my first example focuses on our work with wood ducks in California. We began with a very simple management question on the optimal distribution and dispersion of nest boxes to maximize productivity. That led to a 26 year-long multi-faceted study of the complex social system and behavioral ecology of this enigmatic species which has, in turn, challenged our understanding of the drivers of population dynamics. I build on these insights on birds and behavior to illustrate how we can use core concepts in established foraging theory to develop large-scale bioenergetic models to inform winter habitat planning. Our spatially-explicit agent-based model (SWAMP) enables us to scale up from individual bird decision rules to population level estimates of carrying capacity, lipid reserves, time budgets, movement, and mortality. We have employed SWAMP for conservation planning in three Joint Venture regions (CV, IMW and MAV) and believe it has considerable potential to connect landscape level habitat actions to population outcomes. From this framework I segue to my second topic – plans and people. I have been privileged to participate in several NAWMP efforts including the AHM task group, Continental Assessment team, NSST, Future of Waterfowl workshops, and the writing team of the 2012 NAWMP Revision. At the risk of retrospection, I offer some personal reflections on those efforts, the lessons learned, and the challenges ahead. Perhaps one of the most contentious, but rewarding, was the decision to include “people” (human dimensions) as an explicit goal of the 2012 NAWMP revision. It was an audacious reach, and some felt a bridge too far, yet only a decade later our community has streamed over that viaduct. As society continues to shift, split, and surge, this may be one of the most important challenges we must continue to address in the next decade. This leads to the closing section of my talk – people. I have spent the last part of my career pondering “Who will mind the marsh?” With an aging and urban population, shifting societal interests, and a multitude of complex conservation

concerns, how will we keep waterfowl and wetlands relevant? R3 programs have been vital in recruiting, retaining, and reactivating our hunting constituency, but this is only the first of what I call “P3” – participants, partners, and professionals. Even if we stabilize and grow the number of participants, can we maintain the strong partnerships upon which the foundations of our profession rest? Specifically, as our private sector landowners and duck club managers age, will we have the backfill of a new generation to provide those critical partnerships? Likewise, as our agency and NGO partners get pulled in more directions with less funding, how will we ensure that waterfowl and wetland conservation remain a priority? And finally, are we producing the next generation of professionals – scientists, managers, and policy-makers – who not only have the academic skill set, but also the experiential in-the-field training to carry our mission forward? As a university professor, I worry about the diminishment of our training capacity. I am delighted by the establishment of several endowed chairs and have been an active participant in our newly formed North American Waterfowl Professional Education Plan (NAWPEP) committee, but will this be enough? Al Afton and his colleagues set the stage for a new phase of waterfowl management and research in the 1970’s and 80’s. The challenge to our current generation of participants, partners and professionals will be to recruit, retain and reactivate the next generation of marsh minders.

Monitoring Waterfowl Brood Abundance, Movement, and Survival Using a Drone-Based VHF Radiotelemetry System

Presented by: Grant Rhodes (grhodes1211@gmail.com)

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K.M. Ringelman, School of Renewable Natural Resources, Louisiana State University Agricultural Center
H.C. Sabatier, College of Natural Resources, University of Wisconsin-Stevens Point
B.S. Sedinger, College of Natural Resources, University of Wisconsin-Stevens Point
C.A. Nicolai, Delta Waterfowl

Detecting cryptic animals is crucial to ensuring accurate wildlife population assessments. However, conventional tracking methods often prove costly and inefficient. This study introduces an innovative drone-based VHF radiotelemetry approach to investigate blue-winged teal (Spatula discors) brood abundance, movement, and survival in Saskatchewan, Canada. Our goals were to quantify brood survival and movements, and to broadly evaluate the efficacy of the drone-based telemetry system for studying brood ecology. Using a DJI Matrice 210 quadcopter drone, drone-based radio receiver, and computer-based station, we tracked 26 VHF radio-tagged blue-winged teal hens and their broods weekly during a pilot study from June 25 to August 18, 2023. As marked broods were located, a separate DJI Matrice 30T quadcopter drone promptly collected imagery for enumerating ducklings and determining their age classes. These tools enabled real-time monitoring of brood movements, habitat use, and survival. Of the 27 broods we monitored, 9 hens suffered complete brood loss, while 120 of the 230 ducklings survived. On average, broods relocated three times to different wetlands, and there was substantial individual variation in distance moved. Our investigation underscores the utility of drone-based VHF radiotelemetry for studying waterfowl brood ecology, heretofore one of the least-studied aspects of waterfowl breeding ecology. As we proceed in data collection and analysis, we anticipate that our findings will broadly affect how waterfowl and other wildlife research is conducted.

AI-Assisted Conservation: Developing Tools to Standardize In-The-Field Means to Distinguish Duck Species and Hybrids

Presented by: Sara Gonzalez (sgonzalez28@miners.utep.edu)

S. Gonzalez, University of Texas at El Paso
P. Lavretsky, University of Texas at El Paso

Waterfowl are ubiquitous around the world, explaining their social-economic importance across societies today and in the past. However, phenotypic similarities that persist among many closely related species often make them difficult to differentiate in the field to the untrained eye. Skewed data from natural variation of human perception can easily lead to misidentification and inaccurate data that have direct consequences on conservation decisions. Towards alleviating such biases, we present an Artificial Intelligence (AI)-assisted application that differentiates between closely related waterfowl species, increasing accuracy while standardizing for user bias. Importantly, unlike other AI-driven applications available in the birding community, our models are trained on genetically vetted datasets that allow us to a priori assign genetic ancestry to samples used in AI training. Doing so allows us to build models that are capable of discerning between species and their hybrids with some level of certainty that is not possible today. Currently, we are applying such methods to distinguish between mallards, Mexican ducks, mottled ducks, and their hybrids. Preliminary models have an accuracy of nearly 90%. By using a computer vision system integrated into a user-friendly application, we can obtain better data for further use, including image metadata which includes GPS location as well as time and date, allowing for a real time tracking of populations across the landscape. Importantly, the developed tool will act as an important hunter engagement and recruitment tool as a citizen science project.

simRestore: A Decision-Making Tool for Adaptive Management of the Native Genetic Status of Wild Populations

Presented by: Flor Hernandez (fbhernandez2@miners.utep.edu)

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Anthropogenic hybridization, or direct and indirect human activities that induce higher and non-natural rates of gene flow, is considered a significant threat to Biodiversity. The primary concern for conservation is the potential for genomic extinction and loss of adaptiveness for native species due to the extensive introgression of non-native genes. To alleviate or reverse trends for such scenarios requires the direct integration of genomic data within a model framework for effective management. Towards this end, we developed the simRestore R program as a decision-making tool that integrates ecological and genomic information to simulate ancestry outcomes from optimized conservation strategies. In short, the program optimizes supplementation and removal strategies across generations until a set native genetic threshold is reached within the studied population. Importantly, in addition to helping with initial decision-making, simulations can be updated with the outcomes of ongoing efforts, allowing for the adaptive management of populations. After demonstrating functionality, we apply and optimize among actionable management strategies for the endangered Hawaiian duck for which the current primary threat is genetic extinction through ongoing anthropogenic hybridization with feral mallards. Simulations demonstrate that supplemental and removal efforts can be strategically tailored to move the genetic ancestry of Hawaii's hybrid populations towards Hawaiian duck without the need to completely start over. Further, we discuss ecological parameter sensitivity, including which factors are most important to ensure genetic outcomes (i.e., number of offspring). Finally, to facilitate use, the program is also available online as a Shiny Web application.

Great Lakes Mallard Movements and Population Dynamics

Presented by: Benjamin Luukkonen (luukkon3@msu.edu)

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J.W. Simpson, Winous Point Marsh Conservancy

Large-scale, long-term population monitoring datasets and advances in telemetry technology provide a unique opportunity to simultaneously examine population dynamics and individual heterogeneity. State breeding waterfowl surveys estimate that Great Lakes mallard abundance has declined over 30% since the early 2000's. Mallards are an important waterfowl species in the Great Lakes where an estimated 60-80% of regional mallard harvest is comprised of locally produced ducks. Our goal was to examine Great Lakes mallard movement and population dynamics to identify factors limiting mallard abundance. During 2021-2022, we genetically sampled and marked 435 hen mallards with GPS-GSM transmitters in Michigan, Wisconsin, Ohio, Indiana, and Illinois. We estimated local movement distances, migration probability, and land cover type selection. Using GPS and accelerometer data, we developed an algorithm to identify incubation behavior and estimated probability of nest initiation and success. Further, we incorporated annual abundance estimates and banding data from 1991-2021 to develop an integrated population model and estimated annual survival, productivity, and population change. Genetic analyses indicated 48% of GPS-marked birds were wild x game farm mallard hybrids and 52% were pure wild mallards. Hybrid mallard daily mean displacement, migration probability, and nest initiation probability were significantly lower, and selection of urban developed land cover was 1.3 times greater than for wild mallards. Declines in annual productivity indices and juvenile female survival were positively correlated with population decline. Selection of urban areas, sedentary behavior, and low nesting investment raises concern regarding ecological fitness of hybrid mallards and their impact on the regional population. Management actions that increase productivity and juvenile female survival are most likely to improve the Great Lakes mallard population.

Functional Connectivity of Waterfowl Sanctuaries for Wintering Mallards in the Mississippi Alluvial Valley

Presented by: Nicholas Masto (nmasto1214@gmail.com)

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A.C. Keever, Tennessee Tech University
A.G. Blake-Bradshaw, Tennessee Tech University
C.J. Highway, Tennessee Tech University
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H.M. Hagy, U.S. Fish and Wildlife Service
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Waterfowl sanctuaries are established for a variety of purposes, one of which is to enhance movement of waterfowl among sanctuaries with the implicit assumption that increased movement translates to increase hunting opportunities. In this study, we evaluated functional connectivity between waterfowl sanctuaries within a protected area network for wintering mallards (Anas platyrhynchos) relative to sanctuary sizes (i.e., emigration and immigration), distance between sanctuaries, and age-sex demographics. Specifically, we captured and monitored 421 mallards using GPS transmitters and used a Bayesian multistate modeling framework to estimate the probability of diurnal sanctuary transitions and sanctuary use during winter. Daily transition probabilities to sanctuaries were ≤ 6% with distance primarily driving sanctuary transitions. Specifically, the probability of an adult male mallard transitioning at least once during the entire 120-day study period was 46.1% (90% CRI = 42.1–50.5%) when sanctuaries were 21.1 km apart (\bar{x} distance − 1 SD), 3.4% (90% CRI = 2.9–4.5%) when sanctuaries were 46.9 km apart (\bar{x}), and 0.2% (90% CRI = 0.1–0.3%) when sanctuaries were 72.7 km apart (\bar{x} + 1 SD). Sanctuary sizes, age, and sex were statistically significant but not biologically meaningful. Our findings emphasize distance among sanctuaries as the primary driver of mallard movement which challenges conventional conservation practices that consistently prioritize large areas for protection over small areas, often ignoring isolation effects. Conservation planners that aim to maximize connectivity and movement among sanctuaries for wintering waterfowl should minimize isolation regardless of sanctuary size. State conservation agencies may consider purchasing or leasing smaller stepping-stone sanctuaries between larger ones (e.g., National Wildlife Refuges) to increase connectivity and waterfowl movement. Another worthwhile consideration is the endorsement of private “waterfowl management cooperates” (WMCs) that combine privately-owned resources, habitat management, and establish sanctuary to increase connectivity which may enhance recreational hunting opportunities.

Influence of Sanctuary Disturbance on Waterfowl Harvest Opportunity

Presented by: Abigail Blake-Bradshaw (ablakebradshaw@gmail.com)

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The North American Waterfowl Management Plan (NAWMP) recognizes waterfowl hunters and non-consumptive users as important stakeholders to sustain waterfowl populations through economic and political support for conservation initiatives. Opportunities to shoot at and harvest ducks are key determinants of achievement-oriented hunt satisfaction and quality. Therefore, identifying factors influencing harvest opportunity would identify optimal days afield and promote hunter recruitment, retention, and reactivation (R3) efforts in support of NAWMP. Waterfowl extensively use spatial sanctuaries during hunting, especially diurnally, which could limit their perceived availability to hunters. Thus, a possible management action to support R3 is allowing limited public access on sanctuaries, which could offer recreational opportunities for non-consumptive users and potentially increase harvest opportunities for nearby hunters if disturbance displaces waterfowl from sanctuaries. We evaluated to what extent experimental sanctuary disturbance, landscape characteristics, and weather influenced local harvest opportunities. We disturbed sanctuaries with a covered vehicle (i.e., truck), a pedestrian on foot, and an uncovered vehicle (e.g., motor boat/ATV). To measure harvest opportunity, we used autonomous recording units (ARU) to enumerate daily shotgun volleys across western Tennessee, USA, during 2019–2021 waterfowl hunting seasons. Contrary to our predictions, sanctuary disturbance decreased harvest opportunity. Specifically, the pedestrian disturbance and covered vehicle disturbance decreased daily shotgun volleys by 32% and 31%, respectively. Harvest opportunity decreased 20% with every 5-km increase in distance from a sanctuary. Harvest opportunity increased 2% for every 1°C decrease from mean low temperatures and 9% with every 10-hPa increase in barometric pressure from the previous day. Conversely, harvest opportunity was unaffected by changes in cloud cover, daily precipitation, waterfowl abundance, or surface water inundation. Our results suggest disturbing sanctuaries decreases harvest opportunity and, in turn, may reduce hunt quality and satisfaction. If increasing harvest opportunity is a primary management objective, we recommend limiting sanctuary disturbance to maximize local harvest opportunities.

Leveraging Social Science to Support Equitable and Inclusive Conservation Practices

Presented by: Megan Jones (megan.jones@oregonstate.edu)

M. Jones, Oregon State University

“How do I make my organization more equitable and inclusive?” “What do we do about the fact that some people show up to voluntary DEIJ trainings and others don’t?” “How do I process and persist through difficulties that stem from structural inequalities, or help my colleagues who are struggling themselves?” These are a few of the questions that practitioners in conservation and natural resource management ask themselves and their colleagues, as they reflect on the evolution of the field. Although the questions are in some ways more important than the answers, a turn towards social science can help frame the search for ways forward. We will review some of scholarship in the behavioral sciences, especially psychology, that sheds light on how individuals and organizations grapple with equity, inclusion, and social change. We will discuss these findings in the context of three thorny dualities: interactions between science and advocacy, between values and management, and between beliefs and actions. We will conclude with some tentative principles which may help each of us embed lessons from social science into our daily practice towards more effective, more inclusive conservation.

Building Pathways: The Crossroads of R3, DEI, and Relevancy

Presented by: Taniya Bethke (taniya@cahss.org)

T.B. Bethke, Council to Advance Hunting and the Shooting Sports

According to the US Census Bureau, age bands within the United States are rapidly growing in ethnic diversity. Census results indicated that 2020 marked a tipping point in our country, when youth ages 18 and under became minority white as a population. Projections indicate that the 18–29 year-old age band will become minority white in 2027, with each band being similarly impacted in the years thereafter. In addition, when we look at the results of the America's Wildlife Values project, we see a marked shift in the values and relationships a wide array of populations are developing with wild spaces that differ from traditional outdoor recreationists. When we consider the dominant hunting culture, and the predominant stories that are told and pathways into hunting that are celebrated, they are vastly homogenous, and under-representative of the broader communities within which we all function and serve. As we look ahead to maintaining the relevance of hunting and waterfowl management in current and broader audiences, we will take a deep dive into what it means to build new, more representative, pathways and partnerships that have the capacity to tell the stories of All Americans. Through the discussion of practical strategies, we will take a look at a promising and inclusive future.

Interagency Engagement in DEI: The Importance of Talking Over Fences

Presented by: Adam Phelps (aphelps@dnr.in.gov)

W.A. Phelps, Indiana Division of Fish and Wildlife

Practitioners in the wildlife conservation community are largely white and largely male, and the waterfowl profession is no different. In the aftermath of Mr. George Floyd's murder on May 25, 2020, much of the country reconsidered (or considered for the first time) what and how it thinks about privilege, equity, justice, and a whole host of related ideas. In that spirit, an informal, interagency group of 80+ members from at least 29 US states, 2 Canadian provinces, and 3 federal agencies, as well as non-governmental organizations and the private sector, have been gathering in a community of practice since October 2020. Members are mostly biologists in wildlife agencies, though administrative employees also participate. Discussions among this group have centered on how to engage underserved and marginalized communities not only in conservation activities among our constituents (wildlife watching, hunting, volunteering, etc.) but also within our professions regarding recruitment of new professionals. The waterfowl community is beginning to have these discussions as well, in terms of how we recruit and educate new biologists. Objective Three of the North American Waterfowl Professional Education Plan addresses the recruitment and training of "…an inclusively diverse group of North Americans working in waterfowl science and management programs…" in all Flyways by 2025. This informal interagency group and others like it, such as the Association of Fish and Wildlife Agency's Diversity and Inclusion Working Group, provides much needed support to practitioners who are trying to work for change within their organizations but are seeing slower progress than they would like. These groups can also help agencies and other organizations meet (or even set) their goals for diversity, equity, and inclusion.

Empowering Women's Participation in Hunting and Conservation: Current Trends and Knowledge Gaps

Presented by: Katherine Graham (katherine.graham@huskers.unl.edu)

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Promoting diverse participation in hunting and conservation has been a recent focus of many Recruitment, Retention, and Reactivation programs (R3) since the 2012 revision of the North American Waterfowl Management Plan. However, relatively little is known about what constrains and facilitates women's participation in waterfowl hunting and waterfowl and wetland conservation. Further, what little research has been done has yet to be synthesized, which could improve accessibility for practitioners. In response to this gap, we synthesized the literature on women's participation in hunting and conservation in conjunction with survey and interview data to explore how to support and empower female waterfowl hunter and conservationist participation. Our synthesis suggests that although women's participation in hunting and conservation is increasing, women still participate less actively than men. For example, recent work finds that women are less likely to be retained in the waterfowl hunting and waterfowl conservationist populations and, further, that female waterfowl hunters and conservationists are less likely to purchase waterfowl hunting licenses and conservation organization memberships every year compared to males. Women's lower participation trends in hunting have been attributed to many factors, including more traditional barriers as well as barriers specific to women, such as socialization into hunting. Women's lower participation in hunting may also be due to a lack of confidence in skills and a lack of social support, which are linked to female hunters' feelings of self-efficacy. Regarding conservation organization membership, our synthesis suggests that social support and social capital, which are lacking for many women, are integral to active involvement in conservation organizations. Our research highlights the gaps in our understanding of women's participation in hunting and conservation, informs future research on female participation in hunting and conservation, and can be applied to increase the engagement of women and other nontraditional waterfowl hunters and conservationists.

Partners in Bird Conservation- Working with Alaska Native Tribes, Organizations, and the Alaska Migratory Bird Co-Management Council

Presented by: Patty Schwalenberg (waswagon57@gmail.com)

P. Schwalenberg, Alaska Migratory Bird Co-Management Council, Anchorage, AK

Spring subsistence harvest of migratory birds has been a traditional practice of Alaska Natives since time immemorial. Subsistence is a term used to describe the Alaska Native way of life as it relates to the harvest and processing of wild resources for food, raw materials or other traditional uses.
When the Migratory Bird Treaty Act was enacted in 1918, lawmakers did not consider the subsistence users in Alaska, who rely on catching birds during spring and summer. Thus, this traditional practice was outlawed with passage of the MBTA. Years later, people worked together with Congress to amend the MBTA and remove the illegal stigma associated with spring and summer harvest of migratory birds. As a result, a co-stewardship system was formed to collaboratively address topics related to migratory bird subsistence and management. The Alaska Migratory Bird Co-Management Council is comprised of three partners; the U.S. Fish & Wildlife Service, the Alaska Department of Fish & Game, and Alaska Native communities, represented by the Native Caucus, which includes ten representatives from ten regions of the state who utilize migratory birds for subsistence.
This presentation will provide an overview of subsistence in Alaska as well as the 229+ Tribes and Native organizations that call Alaska home. Current issues and projects of the AMBCC will be shared, including what types of information are important to the people who rely on birds for subsistence. Information will also be shared on how the AMBCC works with researchers, the process for working with the AMBCC, and who the key people are within each partner organization that you should know. Finally, we will discuss the successes and lessons learned from participating in a co-stewardship regime, where we rely on Indigenous knowledge and traditional science methods as well as western science for the successful conservation of migratory birds.

Supporting Inuit Participation in Wildlife Research Across the Short- and Long-Term

Presented by: Grant Gilchrist (grant.gilchrist@ec.gc.ca)

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Many researchers have a sincere desire to support community-based monitoring and Inuit self-determination in research. Many Inuit share a deep concern for the health and management of wildlife populations and have abundant wildlife-related knowledge to share. Because of this natural alignment of interests, there are many stories of successful collaboration. Many of our research projects would have been difficult or impossible to deliver without the collaboration of Inuit, and much of our research is driven by Inuit priorities. Despite the successes, some non-trivial obstacles continue to hinder the shared vision of full participation in wildlife research. Training opportunities are lacking in most communities. Short-term research projects can lead to employment opportunities that are not as meaningful as they could be. Academic funding structures and reward systems don't adequately value the contributions, nor recognize the costs, of co-development and co-delivery of research in the North. The list is long. We have collaborated closely with Nunavummiut for more than 25 years and have developed some insights into what works well. We have found that engaging in Inuit research governance structures can yield benefits, both in terms of funding and in terms of ensuring relevance of the research. While some of our research is highly technical and requires advanced university-level training, much is not and is well suited to a model with more participation of local community members. Also, technology can increase people's ability to collect high quality data without advanced training. Through our Inuit Field Training Program, we have found that many young Inuit are interested in participating in environmental research, and there is significant scope for researchers to increase the availability of employment and training opportunities. Efforts to increase participation of Inuit in research in the short-term, and capacity building for more leadership of research in the long term, are both necessary and possible.

Confronting Colonial History: Toward Healing, Just, and Equitable Conservation Futures

Presented by: Tamara Layden (tamara.layden@colostate.edu)

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Building an understanding of ethics and justice in conservation practice is increasing in demand for diverse professionals in the field. Cultivating this knowledge requires engaging with histories that outline and confront settler colonial injustices relevant to conservation. However, although this information is growing, it remains scattered across various bodies of work and disciplines, often failing to be incorporated into conventional conservation literature. This creates an immense challenge for conservation practitioners, scholars, and other professionals in the field looking to build their environmental justice and decolonial understanding. To meet this growing need, this research provides a brief primer of settler colonial conservation in the Americas, identifying the origins and throughlines in conventional conservation, resulting disparities, and pathways toward a more just conservation future. This synthesis of diverse bodies of work, across disciplines and expert voices, provides an entry point for cultivating a deeper understanding of justice and decolonization in conservation while centering communities and peoples most negatively impacted by settler colonial legacies and ongoing harms.

Field Safety Strategies to Support At-Risk Researchers

Presented by: Lindsay Carlson (lindsay.carlson@usask.ca)

L.G. Carlson, Department of Biology, University of Saskatchewan

Field research involves inherent safety risks–working in remote regions with extreme climates, proximity to dangerous wildlife, and transportation accidents are all factors we consider and train to avoid when planning and preparing for field research. However, because of identity prejudice, certain individuals are vulnerable to safety risks (conflict or violence) not often considered by those who do not have the same identity. At-risk individuals include minority identities of the following: race/ethnicity, sexual orientation, disability, gender identity and/or religion. Recent examples include the culture of unchecked sexual harassment and assault on women geoscientists working in Antarctic field stations, or the troubling incident where police were called on a Black birdwatcher in Central Park, NY. To build and sustain diversity in fields that necessitate fieldwork, the entire scientific community must recognize the vulnerabilities of specific groups within the field and take decisive measures to safeguard at-risk individuals. As with any other risk to health and safety, differential risks posed to minoritized individuals should be considered by supervisors, and a plan enacted to mitigate risk and promote best practices within the research team. This presentation will provide a synthesis of previous work on this topic and deliver readily implemented, common-sense best practices and strategies to initiate conversations and support at-risk researchers in field environments.

Changing Duck Population Sex Ratios: Cause for Concern?

Presented by: Thomas Riecke (thomas.riecke@umontana.edu)

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As early as 1932, Aldo Leopold noted that the sex ratios of duck populations were ‘seriously deranged,’ with male ducks greatly outnumbering females. Duck breeding habitats have experienced substantial alteration and loss in the nine decades since that statement. Female ducks have always experienced greater reproductive costs and reduced survival relative to males, and these disparities may be increasing in the face of anthropogenic landscape alteration. Critically, existing management and monitoring efforts for North American duck populations often assume near parity in male to female ratios. Previous iterations of Adaptive Harvest Management assume that the midcontinent mallard population is 52.46% male, or approximately 11 males for every 10 females. Similarly, the Waterfowl Breeding Population and Habitat Survey assumes that single males or groups of four or less males are all paired to females. Recent and previous research has consistently indicated that the proportion of males may be greater than or equivalent to 0.7, or approximately 23 males for every 10 females. The difference between these two ratios has important implications for monitoring and management. In this plenary symposium, we make the case that many North American duck populations are both more male-biased than current models assume and are becoming increasingly male-biased. We explore potential mechanisms underlying these changes and specifically identify changes in sex-specific mortality as the primary causal mechanism. We link this disparity to both 1) temporal variation in environmental conditions that increase female reproductive costs, and 2) long-term changes in duck breeding habitats that have reduced female survival relative to male survival. We explore these drivers in depth for midcontinent mallards, at a broad level across all prairie-breeding ducks and offer conclusions suggesting immediate action for existing research, monitoring, and management efforts.

How Do Waterfowl Sex Ratios Change: Pacific Black Brant as a Case Study

Presented by: Caroline Blommel (caroline.blommel@colostate.edu)

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While North American duck populations, especially mallards, have experienced potentially drastic changes in sex ratio bias in the recent years, the same cannot be said for all North American waterfowl. Black brant (Branta bernicla nigricans), a coastal migratory goose and culturally important game species along the Pacific Coast, have had a relatively stable sex ratio for the past several decades. Sex ratios can change in waterfowl populations at fertilization (primary), incubation (secondary), or after hatch (tertiary). We synthesized data and estimates from the Tutakoke breeding colony of brant on the Yukon-Kuskokwim Delta in western Alaska to address how brant sex ratios may have changed at each point in their breeding cycle. There is no evidence of brant manipulating primary sex ratios, but breeding females may modulate parental behavior depending on the sex ratio of broods after hatch. Previous estimates of pre-fledgling survival suggest male goslings survive at a lower rate than females while adult and subadult males may be surviving at a slightly higher rate, ultimately resulting in a slightly female-biased but relatively stable population-level sex ratio. We will provide updated sex-specific estimates of juvenile and adult survival to further inform the demographic mechanisms producing the stable sex ratio of brant. Unlike many duck species, brant are serially monogamous and have similar reproductive costs for both sexes, which may be an important mechanism behind their stable sex ratio in addition to early mortality.

What Lincoln's Estimates Suggest About the Midcontinent Population of Mallards: Should We Be Worried?

Presented by: Ray Alisauskas (ray.alisauskas@ec.gc.ca)

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We used Lincoln's method to update estimated abundance of the Midcontinent population of Mallards in North America, 1960 to 2021. Lincoln's method depends on in-hand identification of species, sex and age for both harvest estimates and harvest rate from banded ducks; importantly, this allows estimation of abundance for different sexes and ages in both harvest and banded samples allowing inference about sex ratios and recruitment to fall flight. Although Lincoln estimates at the time of banding in late summer typically far exceeded the traditional annual survey in May (WHBPS), the two showed temporal parallelism from 1961 to 2009 (r = 0.53) but seemed unrelated from 2010 to 2019 (r = 0.16). Note that Lincoln estimates were available for years during the COVID19 epidemic when WHBPS estimates were not. Adult (after-hatch-year, AHY) Mallard abundance in late summer inferred from Lincoln's method showed a strong and expected response (r2 = 0.66) to Conservation Reserve Program (CRP) acres in the Dakotas, but May WHBPS estimates did not (r2 = 0.06). Lincoln estimates of adult Mallard abundance declined rather steadily from a maximum of 25.4 million in 1999 to ~6 million in 2020. Lincoln's method permitted estimation of female Mallard recruitment (HY:AHY female) with apparent negative density dependence (r2 = 0.41), and a positive response to pond number in Canada and the US (r2 = 0.41) in a multifactorial model. Finally, sex ratio (males:females) derived from Lincoln estimates increased (r2 = 0.83) in AHY Mallards from ~1.8 in the early 1960s to >3.5 by the 2010s. Sex ratio in HY Mallards was stable (r2 = 0.07) by comparison. The increased AHY sex ratio is consistent with an increasing disparity in survival between males (higher survival) and females (lower survival) in both AHY but also HY Midcontinent Mallards. We encourage researchers and managers to consider Lincoln estimates in models of Midcontinent Mallards and other species of ducks in North America, where rich data sets for harvest and banded birds exist for many species.

Cross-Seasonal Survival Models Indicate that Increased Female Summer Mortality Drives Diverging Sex Ratios in Midcontinent Mallards

Presented by: Benjamin Sedinger (bsedinge@uwsp.edu)

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Demographic studies of plant and animal populations are the foundation of conservation biology, wildlife and land management, and much of ecology and evolutionary biology. When available, census and mark-reencounter data are a valuable resource that can be used to estimate population parameters to inform demographic studies. Additionally, if marking occurs more than once per year, then demographic parameters can be estimated for seasons within the annual cycle. For example, survival can be estimated for the hunting season and the non-hunting season during a given year for duck species with sufficient sample sizes. In North America, waterfowl have been surveyed, marked, and reencountered for decades, including some seasonal marking of individuals that occurs prior to and following legal hunting seasons. Recent analysis of these data, particularly Lincoln estimates of abundance, have revealed diverging adult sex ratios among many species although the underlying mechanism is unclear. Therefore, we evaluated the hypothesis that diverging sex ratios in some North American waterfowl populations can be explained by differential survival associated with sex-specific costs of reproduction. Specifically, we used Bayesian hierarchical model structures to examine age- and sex-specific seasonal mortality rates of North American mallard (Anas platyrhynchos) populations from 1961-2019. We show that mortality occurring outside of the hunting season exceeds all mortality during the hunting season. Further, our results indicate that mortality outside of the hunting season is mediated by climactic factors during the breeding season that disproportionately affect females. Thus, survival differences between adult males and females are being driven by reproductive costs, and provide a clear mechanism for diverging sex ratios among mallards, and likely other waterfowl populations in North America. We advocate for continued seasonal banding of waterfowl and discuss important implications for current and future conservation and management actions directed towards waterfowl populations.

Sex-Specific Survival in Mallards May Be Related to Spatial Variation in Habitat

Presented by: Madeleine Lohman (mlohman@nevada.unr.edu)

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Complex interplays of the environment, life histories, and broader population dynamics often generate changes in sex ratios within wildlife populations. Specifically, sex-specific survival, partly driven by environmental factors and the costs of reproduction, may contribute to changing sex ratios of mallards in the midcontinent. Reductions in quality habitat may lead to increased competition between males and females, with males dominating. Similarly, reproduction costs, including increased predation and energetic costs, may decrease female survival relative to males. Focusing on spatial variation in habitat and fecundity, we hope to elucidate the spatial and temporal drivers of sex-specific survival and, thus, changing sex ratios. Using a conditional autoregressive model to account for spatial autocorrelation, we estimated site-specific fecundity and survival for mallards in the Prairie Pothole Region from 1974 – 2016. We also modeled the potential effects of agriculture and pond counts on these demographic rates. We found adverse effects of agriculture on juvenile female survival but very few effects of covariates on any other age or sex class. Results also pointed towards a negative relationship between fecundity and adult female survival. These results suggest that both reproductive costs and agricultural coverage may lead to differences in survival in male and female mallards that generate changing sex ratios.

Shifts in Sex Ratios of Dabbling, but Not Diving Ducks Are Driven By Declines in Survival of Females

Presented by: Daniel Gibson (gibsond@vt.edu)

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Changes in breeding sex ratios can influence population growth rates through shifts in the reproductive potential of a population. Across species the mechanisms driving sex ratios can be complex. However, in systems where the primary sex ratios are even (e.g., waterfowl), shifts in sex ratios are often a function of differences in survival between the sexes. Furthermore, insights in how sex ratios have changed across species may help identify mechanisms driving changes in population structure. Here, we have built an integrated community model informed by data describing variation in sex-specific abundance, production, and survival of eleven species of ducks that breed in the Prairie Pothole Region of North America to identify the demographic rates associated with variation in sex ratios, and determine if shifts in sex ratios were ubiquitous across the dabbling or diving duck community. We found that the sex ratio for 6 out of 7 dabbling duck species considered have recently become increasingly male-biased, but this pattern was only observed for 1 of 4 diving ducks. Shifts in sex ratios coincided with a decline in the annual survival of juvenile and adult females along with an increase in the survival of juvenile and adult males. Critically, we found that the sex-specific harvest rates for nearly all combinations of species and age-classes were 1) greater for males; and 2) becoming increasingly male biased, which indicated that shifts in harvest dynamics could not be causing populations to become more male-biased. Together, this suggests that the observed shifts in sex ratios are driven by recent increases in the natural mortality of females relative to males. We posit that changes in breeding habitat conditions throughout the Prairie Pothole Region have driven the observed increase in female natural mortality but further research is required to understand mechanisms.

Implications of Changing Duck Population Sex Ratios for Habitat and Harvest Management

Presented by: Thomas Riecke (thomas.riecke@umontana.edu)

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Changing sex ratios of North American duck populations present a management and monitoring crisis. Existing monitoring programs (e.g., WBPHS and state-level surveys) likely incorrectly assume that most unpaired males are members of an indicated breeding pair, biasing estimates of total population size and effective population size (i.e., true breeding pairs). Similarly, population models used to forecast population change and to manage harvest (e.g., AHM) may bias population projections because of the corresponding overestimate of the number of females assumed in the population. These challenges hinder our ability to make informed management decisions. Fortunately, existing datasets and novel analyses seem to have permitted improved estimates of changes to true sex ratio and perhaps a better understanding of ecological drivers behind these changes. Furthermore, changing sex ratios may also offer a substantial research and management opportunity. An exceptional surplus of males in the population provides managers with room for experimental harvest regulations targeted at males, with little risk of reducing effective population size. Experimental regulations might jointly: 1) allow for learning, leading to improved harvest management decisions, and 2) provide increased hunter opportunity. Similarly, acknowledgement and adjustment of incorrect assumptions about population-level sex ratios can improve predictions from models used to make population and harvest management decisions. Skewed and changing duck population sex ratios represent surmountable challenges to informed duck population management and monitoring. Unbiased estimates of increasingly skewed sex ratios in favour or males will provide an opportunity to properly understand populations, and to provide more informed management recommendations.

Waterfowl Management: A Century of Progress and Future Challenges

Presented by: Dale Humburg

D. Humburg, Ducks Unlimited, Inc. (Retired)
D. Eggeman, Ducks Unlimited, Inc.
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Waterfowl management continues to evolve as it has done for more than a century. Changes have occurred in bureaucracy, harvest regulations, habitat conditions, conservation support, and natural resource professions. Decades of constant adaptation reflect the dynamic habitat and social conditions within which waterfowl managers operate. Federal, state, provincial, and private waterfowl conservation interests must continue to adapt to this changing context. The challenge ahead, as always, will be to maintain political and professional relevance … keep the fire lit!
Emphasis on habitat conservation and management continues as threats to wetlands have increased – likely at a rate and impact greater than conservation efforts. Waterfowl managers face their primary challenge in efforts to protect, restore, and manage important waterfowl habitats in critical landscapes.
Waterfowl harvest management continues to change as managers communicate explicit objectives, monitor management responses, and better inform decisions. Managers periodically adjust regulations in response to contemporary hunter desires and system dynamics and address emerging questions about the impact of harvest on distribution and habitat use.
Emphasis on human dimensions –the essential basis for waterfowl and wetland conservation – has increased considerably in the past decade. The critical role of waterfowl hunters as conservation supporters must be perpetuated while engaging other passionate and effective conservationists to fight for resource protection and management. An increasingly diverse array of partnerships with new communities will be essential.
The waterfowl profession itself has advanced in response to changing perspectives, emerging information, political hurdles, habitat threats, and waterfowl population trends. Emphasis has shifted from harvest management to habitat conservation and further to conservation supporters. The profession has expanded from harvest managers and waterfowl “farmers” to include modelers and human dimensions expertise in response to evolving ecological and social landscapes. A wide array of professional talents and expertise are needed to meet today’s and tomorrow’s challenges.

Waterfowl Monitoring and Management: Resiliency in a Resource Constrained Future

Presented by: Patrick Devers (Patrick_devers@fws.gov)

P. Devers, S. Boomer, T. Cooper, K. Fleming, M. Koneff, K. Richkus, T. Sanders, D. Scott, and M. Seamans

U.S. Fish and Wildlife Service, Division of Migratory Bird Management

Continental-scale monitoring and management of waterfowl in North America have a long and rich history of collaboration and improvement that have culminated in a scientifically-informed system for decision making with many benefits. As an important component of this system, long-term population, banding, and harvest data have supported development of models to predict the effects of the environment and human actions such as hunting and habitat management. Ongoing surveys enable comparison of model predictions with observations, providing an opportunity to learn about system dynamics and improve decision-making over time. Both monitoring programs and the management processes they support have been subject to ongoing review and modification over time and adapted to changing objectives, technologies, and analytical tools to ensure appropriate focus and efficiency. Today, changing societal attitudes, agency priorities, and increasing budgetary constraints present both challenges and opportunities in positioning these systems for increased resiliency in an uncertain future.

Risk and Resilience: A Call for Flyway Scale Habitat Monitoring in the New Era of Climate Change

Presented by: Patrick Donnelly (patrick_donnelly@fws.gov)

P. Donnelly, Intermountain West Joint Venture

Migration is fundamental to avian ecology, allowing birds to move between breeding and wintering locations to capitalize on favorable food and weather conditions. Emerging ecological bottlenecks driven by accelerating climate and land use change have substantially increased the challenges for migratory bird conservation. Waterfowl are particularly vulnerable to these changes due to life history strategies supported by an interdependent network of diffuse geographic regions that can expose populations to multiple independent risks. Risks are compounded by cross-seasonal effects where environmental conditions experienced in one location (breeding grounds, wintering grounds, or stopover areas) can affect fitness in subsequent regions, leading to declines in long-term demographic performance. While there is evidence some waterfowl have changed migration chronology and range extent to align with shifting climate and land-use patterns, increasing environmental pressures may outstrip the adaptive plasticity of some species. Adapting conservation strategies to rapidly evolving flyway conditions will require improved access to historical and real-time ecological information that is spatially explicit and transcendent of international boundaries.
Cloud computing and AI technologies coupled with high-resolution satellite data have made tracking meaningful environmental change at the continental scale feasible. Leveraging these technologies will require novel investment in human capital with the capability to develop large-scale ecosystem monitoring framework to complement the existing demographic focus of waterfowl science. Outcomes have the potential to unite NAWMP, Joint Venture, and flyway planning under a common, meaningful, and accessible information platform to support holistic (i.e., full life cycle) waterfowl habitat conservation. This talk will review recent science highlighting changes to ecological and agroecological systems supporting continental waterfowl populations and explore the potential opportunities and challenges of developing flyway ecosystem monitoring platforms for North America.

Prairie Pothole Region Status Report: Implications for Continental Duck Populations

Presented by: Scott Stephens

S. Stephens, Director of Prairie and Boreal Conservation Strategy, Ducks Unlimited, Inc.
J. Walker, Director of Operations – Great Plains Region, Ducks Unlimited, Inc.
V. Harriman, Research Scientist, Institute for Wetland and Waterfowl Research, Ducks Unlimited, Inc.
J. Vest, Science Coordinator, Prairie Pothole Joint Venture

The Prairie Pothole Region (PPR) of Canada and the U.S. is the most important breeding area for ducks in North America and fundamental for maintaining healthy populations of ducks across the continent. However, this region also remains under tremendous pressure to produce food, fiber and energy for a growing world population, which conflicts with maintaining functional habitat for waterfowl. The spring of 2011 represented the most widespread, favorable wetland conditions across the expanse of the PPR seen in several decades. Those conditions set the stage for historic population growth of the total duck populations in the PPR and across North America. However, since that time conversion of upland nesting habitats and wetland habitats to cropland has continued. We will provide an overview of the trends in those key upland and wetland habitats as well as progress on securing and restoring habitats via Joint Venture partners in the Prairie Habitat Joint Venture and Prairie Pothole Joint Venture over the past 13 years. The status and progress on important policy facets that either help maintain or increase key habitats will also be discussed along with a prospective look at the path ahead for important conservation, policy and science efforts to ensure that the PPR continues to be capable of producing “booms” in duck populations when favorable environmental conditions exist there.

Meeting Cross Seasonal Habitat Requirements of Waterfowl in a Shrinking Wetland Landscape

Presented by: John Vradenburg (john_vradenburg@fws.gov)

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C. Brady, California Department of Fish and Wildlife
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P. Donnelly, Intermountain West Joint Venture

The success of waterfowl management is dictated by global conditions that drive habitat availability at the continental, regional and local scale. The life history strategies of waterfowl allow them to adapt to within and among year shifts in conditions and habitat availability. However, increasing climatic variability, modifications to the landscape, and decreasing predictability in water availability have compromised the resiliency of wetland systems and complicated waterfowl habitat management. The Pacific Flyway is the driest of the four North American flyways and a case example of the stressors that could soon impact waterfowl populations at a continental scale. Due to the flyways limited availability of wetland habitat and the unique conditions that support a variety of life cycle needs, specifically nesting and molting in the mid and lower latitude states of the flyway, the impacts of climate change and policy driven water scarcity are impacting within and among year constraints on waterfowl populations. Mid, and lower latitude wetland complexes have been functionally removed from the landscape compromising waterfowl that use these landscapes throughout the year and increasing competition for limited habitat and food resources during migration and wintering periods. Southern Oregon, Northeastern California, and the Central Valley of California support large populations of waterfowl throughout the year. However, available wetland habitat, primarily comprised of flooded agriculture and intensively managed wetland complexes, are dependent upon annual water allocations. Both habitats have little protection from changing market conditions, water shortages, and competing demands for limited water resources (i.e., anadromous fish). Harvest management decisions in the Pacific Flyway revolve around mallard production in Alaska and mid and lower latitude states (i.e., Washington, Oregon, California, etc.), however, water allocation priorities have functionally removed most of the wetland habitat during the breeding and molting periods resulting in a breeding crisis for mid and lower latitude nesting waterfowl. Lack of mid and lower latitude waterfowl production could have carryover effects on Pacific Flyway harvest management decisions due to the loss of critical wetland habitat in nesting and molting areas. The conflicts around waterfowl habitat management and water scarcity in the Pacific Flyway serve as a case example and a warning for other flyways as the issue of water scarcity is moving east. Ensuring land managers can manage wetland habitats to achieve and maintain continental waterfowl population

objectives that drive harvest management hinges on protecting and securing water resources for the limited habitat that remains on the landscape.

The North American Waterfowl Management Plan: 40 years of Adaptive Conservation. Where Do We Go Now?

Presented by: Tom Moorman

T. Moorman, U.S. Co-Chair, NAWMP 2024 Update
T. Sopuck, Canada Co-Chair, NAWMP 2024 Update

The North American Waterfowl Management Plan (NAWMP) was created in 1986 by visionary waterfowl managers in response to declining waterfowl populations. Joint Ventures are the core of the NAWMP business model – multiple partners with mutual interests in waterfowl and wetlands bringing resources to significant conservation challenges at landscape scales. While NAWMP implementation has been both adaptive and extraordinarily successful in conserving waterfowl habitat, acute significant threats to waterfowl and their associated habitats remain. Competing land and water uses continue to degrade habitat, while climate change presents new threats and challenges to waterfowl and other species of birds and wildlife and their habitats. The most significant and fundamental challenge for the NAWMP conservation community is achieving habitat conservation at Joint Venture scales that neutralizes or reverses large-scale losses. Substantial additional resources must be injected into the NAWMP Joint Ventures to achieve conservation at scale.

Habitat conserved under NAWMP provides significant benefits to waterfowl, but also to people and their communities. Wetlands improve water quality, sequester carbon, attenuate flooding, provide habitat for a diversity of wildlife and fish, and places for people to connect with nature. NAWMP is one of the best examples of the use of nature-based solutions to address climate change and other environmental issues on a broad, landscape-level scale. Indeed, some Joint Ventures or other partners have documented conservation outcomes that have led to increased wetland conservation, improved wetland policies, and attracted new partners.

NAWMP will remain focused on waterfowl and wetland conservation, but there is substantial opportunity to grow conservation via communication of multiple ecological benefits to attract new partners and resources. More partners, bringing more resources, will increase the scale and rate of habitat conservation on behalf of North American waterfowl, while simultaneously providing other ecological benefits to people and communities across the continent.

Integrating People in Waterfowl Conservation

Presented by: Diane Eggeman (deggeman@ducks.org)

D. Eggeman, Ducks Unlimited, Inc.
D.J. Case, DJ Case & Associates

Waterfowl conservation in 2024 is more challenging than ever. Our profession often laments that we are losing ground faster and faster and our ability to effect change is not keeping up. Much of this symposium rightfully focuses on the biological and physical sciences and management of waterfowl. This presentation will explore what it means to integrate “people” into waterfowl conservation. Specifically, we'll discuss how as individuals, we can use opportunities in human dimensions, communications, and public engagement to advance waterfowl conservation. Based on personal experience and sound social science, we’ll share lessons learned and recommendations on what each of us can do to be a more effective waterfowl conservationist.

Migratory Bird Joint Ventures: Delivering Waterfowl Conservation and More, Now and in the Future

Presented by: Tony Roberts (anthony_roberts@fws.gov)

T. Roberts, USFWS Migratory Birds
B. Wilson, Gulf Coast Joint Venture
M. Iglecia, Pacific Birds Habitat Joint Venture

Migratory Bird Joint Ventures are cooperative, regional partnerships that work to conserve habitat for the benefit of birds, other wildlife, and people. Since the North American Waterfowl Management Plan called for their establishment in 1986, Joint Ventures have grown to service nearly all of the U.S., Canada, and Northern Mexico. Joint Venture partnerships are inspired by a shared vision of a North American Landscape where diverse populations of native birds thrive.

There are twenty-two habitat-based Joint Ventures, each addressing the bird habitat conservation issues found within their geographic area. In addition, three species-based Joint Ventures, all with an international scope, work to further the scientific understanding needed to effectively manage populations of specific bird species. Joint Venture funding comes from Congressional appropriations, administered through the U.S. Fish and Wildlife Service, and the partnerships leverage additional federal and non-federal dollars to improve cost effectiveness of Congressional funds.

In the late 1990s through mid-2000s, Joint Ventures expanded from waterfowl-focused to include other important bird guilds within each respective geography. This shift aligns with the contemporary vision of these partnerships, but comes with necessary, region-specific trade-offs and prioritizations. Joint Ventures use a variety of tools to strategically plan for and deliver conservation and address critical needs in their geographies. We will provide a snapshot of the collective impact of conservation Joint Ventures on the conservation landscape and provide examples of approaches that these vital partnerships have taken to address the expanded focus since 1999.

Machine Learned Daily Life History Classification Using Low-Frequency Tracking Data and Automated Modeling Pipelines: Application to North American Waterfowl

Presented by: Cory Overton (coverton@usgs.gov)

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E. Matchett, U.S. Geological Survey
D. Mackell, U.S. Geological Survey
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To understand and manage animal behavior, it's important to track their movements and patterns. Short-term patterns can be classified with high-frequency data, but longer-term patterns are more relevant to biology and management. We used GPS data to make daily activity classifications for 5 waterfowl species with machine learning.

Automated pipelines use computer-generated code to complete various tasks, including feature engineering, model development, and hyperparameter tuning. Our pipeline produces daily classifications of waterfowl activity patterns using three feature sets: GPS locations, habitat information, and movement history. Each feature set uses different data sources or measures across different time intervals to develop independent variables for the models.

Automated modeling pipelines quickly developed reproducible data preprocessing and analysis steps, identified optimized models, and interpreted feature importance. Using a weighted F1-score to balance recall and precision, we found that models using all feature sets outperformed those with fewer features, particularly for rarer but impactful life history states like nesting. The best model achieved a weighted F1-score of 0.95.

Automated pipelines generate accurate classifications of daily activity patterns using low-frequency GPS. Real-time classification is possible, but adding habitat and longer sequences of spatial info causes slight delays. Ideal for time-sensitive needs like identifying reproduction. We are developing a web-based application for other researchers to use which will conduct necessary pre-processing steps, apply our model pipeline, and produce classifications for their own data.

Movement Patterns and Risks from Anthropogenic Stressors for Scoters Wintering in the Salish Sea

Presented by: Megan Ross (megan.ross@ec.gc.ca)

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Sea ducks (Tribe Mergini) interact with human-altered coastlines and marine waterways, exposing them to anthropogenic stressors associated with shipping and recreational vessel traffic. The Salish Sea is a high traffic waterway shared between Canada and the USA that was recently recognized as a Sea Duck Key Site by the Sea Duck Joint Venture. Conservation planners in this region lack high resolution data characterizing daily and seasonal movements of sea ducks during the non-breeding season that could help to reduce risks associated with vessels, such as oil spills. We marked 56 Surf scoters (Melanitta perspicillata) and 33 White-winged scoters (Melanitta fusca) with GPS-GSM transmitters in the Salish Sea in November-December 2021 and 2022. Devices were programmed to collect GPS fixes every ca. 3 hours while birds remained within the Salish Sea, and every 24 hours during spring migration and during the breeding season. Transmitters provided between 6 and 12 months of positional data and ancillary information such as altitude, ground speed and heading. We calculated species-specific, Kernel utilization-based distributions for marked scoters. We identified areas of importance during two distinct time (night, day) and seasonal (winter, spring) periods. We used available Automatic Identification System (AIS) vessel traffic data to explore how scoter core use areas interact with anthropogenic stressors associated with vessel traffic including exposure risk to both operational (smaller scale often intentional discharge) and catastrophic (large scale accidental) oil pollution. We expected that diurnal and nocturnal movement patterns could result in exposure to different risks – exposure to smaller faster vessels and smaller oil spills when nearshore versus exposure to larger vessels, larger oil spills and light pollution in offshore environments. Large transboundary marking efforts such as these are invaluable for effective marine spatial planning and assessing risk in the event of an environmental emergency.

Movement Ecology of Mottled Ducks in a Novel Environment: The South Texas Brush Country

Presented by: Jay VonBank (jvonbank@usgs.gov)

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The Western Gulf Coast (WGC) mottled duck (Anas fulvigula) is a non-migratory resident species whose population resides primarily along the Louisiana and Texas coasts. The WGC population has undergone a moderate decline over the last several decades, especially apparent in the Texas portion of the population. While Midwinter surveys suggest the WGC population has declined along the coast, abundance estimates have recently increased in a non-coastal region, the South Texas Brush Country. Over the last decade, midwinter survey estimates show that the Brush Country have accounted for 33.2–76.1% of all mottled ducks counted in Texas, and counts have been greater in the Brush Country than coastal Texas in 3 of 4 most recent years. However, the habitat types and landscape composition in the region, and their influence on life-history traits, are evolutionarily novel to mottled ducks. To understand habitat use and movements in the Brush Country, and potential connectivity with coastal areas, we deployed internal GPS/GSM transmitters in coastal Texas and the South Texas Brush Country in 2022–2023. We observed a 33% emigration rate from the Gulf Coast into the Brush Country, but no birds emigrated from the Brush Country. Oil and gas development in the region is extensive, and we observed mottled ducks regularly utilizing oil and gas-related water features such as fracking ponds and evaporation ponds, as well as other man-made wetlands such as stock tanks, in addition to natural wetlands. Interestingly, mottled ducks regularly used supplemental feed sources in the form of deer feeders as foraging resources, where 60% of Brush Country ducks and 17% of Gulf Coast ducks used feeders. Data collection is ongoing, but here we report initial findings of habitat selection in the Brush Country and compare movement metrics (e.g., home ranges, daily movement distances) between coastal and Brush Country samples.

Risk Assessment for Wildlife Disease (Avian Influenza) Using an Animal Movement Approach

Presented by: Elliott Matchett (ematchett@usgs.gov)

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From an economic and health perspective, understanding the spatial and temporal spread of epizoonotic disease such as the highly pathogenic avian influenza virus (HPAIv), would provide critical information for managing risk of disease outbreaks in wildlife, domesticated animals, and infection in humans. In 2021–23, HPAIv has thus far affected ~168 wild bird and ~18 mammal species, ~59 million poultry in 47 states, and has costed the U.S. poultry industry and government billions of dollars. We evaluated co-location of county-level HPAIv detections in wild birds and poultry (tracked by U.S. Department of Agriculture and the Canadian Food Inspection Service) and 15.8 million telemetry GPS locations from 1,305 individuals of 16 waterfowl species of waterfowl for

2015–2022. Then, we produced a novel empirical contagion model using HPAIv detection and telemetry datasets to predict potential HPAIv introduction to counties and future spread through migratory waterfowl in 2021–22. We assessed model performance by comparing timing of model-predicted HPAIv introduction and first detection in each of 6 wild bird and poultry taxonomic groups for each county. Our model accurately predicted HPAIv introduction (was a leading indicator relative to county HPAIv detections) in 3 or 4 bird groups including migratory waterfowl but not American White Pelicans, resident waterfowl/captive species (Pacific Flyway), or commercial poultry, suggesting that telemetry more species could improve HPAIv prediction. Our results demonstrate the importance of extensive multi-species tracking to provide vital advance warning of potential high-risk disease spread locations and help effectively limit and manage outbreaks in wild birds and poultry. Moreover, predictive modeling results demonstrated for waterfowl suggests the potential for integrating waterfowl and other wildlife GPS tracking data in biosurveillance programs, such as the long-established USGS-NWHC's Wildlife Health Information Sharing Partnership Event Reporting System (WHISpers), to help inform spatiotemporal risk of future epizoonotic disease outbreaks.

Customized Wildlife Reports: Streamlining GPS Telemetry Data for Enhanced Wildlife Management

Presented by: Austen Lorenz (aalorenz@usgs.gov)

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We developed an innovative tool aimed at simplifying wildlife GPS telemetry data interpretation and facilitating more effective wildlife management called Customized Wildlife Reports (CWR). CWR provides a range of highly reproducible reports, currently including "Refuge," "State," and "Species" reports, all of which can be tailored by date, species, and location. Developed through close collaboration with wildlife biologists and decision-makers, CWR present maps, tables, and figures in an interactive user-friendly format.

CWR's primary objectives revolve around improving access to wildlife GPS Telemetry data and enhancing its comprehension, allowing wildlife managers to focus on animal behavior and management rather than grappling with data complexities. The tool harnesses near-real-time data and reduces the need for specialized skills such as GPS telemetry data management and GIS analyses. By prioritizing user customization, interactivity, and simplicity, CWR empowers wildlife managers to efficiently extract valuable insights. Its highly reproducible reports maintain ease of use, enabling professionals to swiftly identify behavior patterns, leading to more informed decisions in wildlife management and conservation efforts.

Customized Wildlife Reports represents a significant leap in turning GPS telemetry data, typically used for research due to time and technical constraints, into an insight rich management tool. CWR's adaptability promise to inform ecosystem management at spatially and temporally meaningful scales. These reports offer a vital resource, enabling wildlife managers and stakeholders to rapidly comprehend complex telemetry data, thereby enhancing their capacity to make informed decisions and contribute to more effective wildlife conservation.

Managing a Team with Mental Health in Mind: Clinical Insights, Current Examples, and a Community Discussion of Best Paths Forward

Presented by: Auriel Fournier, Paul Link, Ben O'Neal, Mitch Weegman, Jeffrey Edwards, Sara Kinder

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B. O'Neal, Franklin College
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S. Kinder

Supporting and supervising staff and students requires training and management towards many goals, including rigorous science, building new skills, and developing as a professional and a human being. Few who supervise staff and students receive training in how to do so, and when those we supervise have challenges outside of learning how to write or code, it can be challenging for the supervisors to know how to create a workplace where students and staff can ask for help. This session will include a presentation from a professional with expertise in student mental health support, waterfowl professionals sharing their experiences in supporting students with the goal of starting conversations around how we as a field can do a better job, as well as sharing resources and practices that others can consider adopting on their own teams. This session is aimed at an audience of waterfowl professionals who currently supervise staff or students, or those who are looking to be in that position in the coming years.

Characterizing the Population Dynamics of Waterfowl Breeding in the Intermountain West

Presented by: Casey Setash (casey.setash@state.co.us)

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Waterfowl populations in the Intermountain West rely upon water availability and are not as frequently studied as populations within North American core breeding areas like the Prairie Pothole Region. Different species experience different environmental conditions during peak nest initiation depending on their breeding phenology, especially in variable environments like those associated with high-elevation systems. We fit species-specific integrated population models to evaluate the demographic drivers of mallard and gadwall populations breeding in a high-elevation intermountain basin in Colorado representative of many Intermountain West habitats from 2018-2022. Each species initiated nests at opposite ends of the phenological spectrum, allowing us to assess the effects of environmental conditions on demography. Both mallard and gadwall annual after-hatch-year (AHY) female survival probabilities were comparable to estimates from other regions (hatch-year [HY] mallards = 0.48 [SD = 0.09] to 0.53 [SD = 0.07], AHY mallards = 0.53 [SD = 0.07] to 0.57 [SD = 0.05], HY gadwall = 0.44 [SD = 0.13] to 0.52 [SD = 0.14], AHY gadwall = 0.56 [SD = 0.11] to 0. 66 [SD = 0.12]). Annual recruitment, a metric of the number of females produced per breeding pair, was similar among gadwall (0.62 [SD = 0.80] to 1.04 [SD = 1.04]) and mallards (0.40 [SD = 0.48] to 1.59 [SD = 0.95]), but realized population growth rate (λ) did not vary as much for gadwall (0.93 [SD = 0.56] to 1.21 [SD = 0.59]) as it did for mallards (0.76 [SD = 0.24] to 1.55 [SD = 0.24]). Recruitment of both species exhibited quadratic relationships with spring growing degree days, indicating recruitment was higher during springs with intermediate temperatures, and spring snow-water equivalent metrics in the surrounding mountains positively impacted HY and AHY mallard survival in addition to HY gadwall survival. The results of this study emphasize the need for continued monitoring of waterfowl outside of traditional survey areas and provide insight into water management strategies to target important vital rates as climate and land use change.

Explaining the Environmental Drivers and Demographic Mechanisms Leading to the Divergence of Population Trajectories for Canvasbacks and Redheads

Presented by: Daniel Gibson (gibsond@vt.edu)

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Despite decades of research and monitoring efforts, our understanding of factors regulating population dynamics of prairie diving ducks (Aythyini) lags far behind our knowledge of prairie dabbling ducks (Anatini). This is potentially attributable to lower-density populations and difficulties studying overwater nesting species, but diving ducks, especially Canvasbacks (Aythya valisineria) and Redheads (A. americana) have always been species of special conservation concern. We developed an integrated population model based on sixty-two years of ecological data describing the demographic histories of Canvasbacks and Redheads, two species of diving ducks that utilize similar habitats and affect each other's demography through intra- and inter-specific nest parasitism. We combined this model with a transient Life Table Response Experiment to determine the extent that demographic rates, and their contributions to population growth, were similar between these two species. We found that demographic rates and their contributions to population growth largely covaried between Canvasbacks and Redheads, but the trajectories of population abundances widely diverged between the two species from 1980–2000 due to Canvasback population dynamics being more, relative to Redheads, sensitive to community composition (e.g., interspecific density dependence) and harvest pressures. Although aerial surveys suggest that both Canvasback and Redhead populations have exhibited no net declines over the last 65 years, our IPM that utilizes both aerial survey and Lincoln estimates of population size raises concerns that Canvasback populations may have declined precipitously. Reductions in harvest pressure and improvements in the environmental conditions that promote submerged aquatic vegetation in key wintering areas for each species mediated the extent to which populations of both species declined. However, our results conclusively demonstrated that long-term reductions in fecundity driven by shifts in breeding pond abundance and agriculture intensity throughout the prairies of North America have limited the extent to which both species could exhibit consistent periods of population growth.

A Life-History Spectrum of Population Responses to Simultaneous Change in Climate and Land Use

Presented by: Frances Buderman (fbuderman@psu.edu)

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Climate and land use change are two of the primary threats to global biodiversity; however, each species within a community may respond differently to these aspects of global change. We used a long-term (1958–2011), large-scale, multi-species dataset for waterfowl that spans the United States and Canada to estimate species-specific responses to climate and land use variables in the Prairie Pothole Region, a landscape that has undergone significant environmental change across space and time. We first estimated the effects of change in climate and land use variables on habitat selection and population dynamics for nine species. We hypothesized that species-specific responses to environmental change would scale with life-history traits, specifically: longevity, nesting phenology and female breeding site fidelity. We observed species-level heterogeneity in the demographic and habitat selection responses to climate and land use change, which would complicate community-level habitat management. We detected several relationships between life-history traits, particularly nesting phenology, and species' responses to environmental change. One species, the early-nesting northern pintail (Anas acuta), was consistently at the extreme end of responses to land use and climate predictors and has been a species of conservation concern since their population began to decline in the 1980s. By distilling the diversity of species' responses to environmental change within a community, our methodological approach and findings will help improve predictions of community responses to global change and can inform multi-species management and conservation plans in dynamic landscapes.

Recent Declines in Population Indices for Spectacled Eiders on Both Breeding Areas in Alaska

Presented by: Erik Osnas (erik_osnas@fws.gov)

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Spectacled eiders are known to breed in three primary locations: the Yukon-Kuskokwim Delta (YKD) and the Arctic Coastal Plain (ACP) of Alaska, and Arctic Russia (AR). In 1993, the species was listed as Threatened under the U.S. Endangered Species Act (ESA) primarily due to a rapid and continuing population decline on the YKD breeding grounds. After listing and until ~2010, there was a steady increase in the YKD breeding population (as observed in the YKD Coastal Zone Aerial Survey indicated total bird index). At times the population index was increasing at up to 8% per year. After 2010, the population index appeared to stabilize, and in the most recent 3 years (2021-2023), the index has been down >50% from its high point. In contrast, the ACP breeding population (as observed in the ACP breeding pair aerial survey) has been generally stable to slightly declining since listing, but similar to the YKD, the indicated total bird index on the ACP also dropped considerably in 2022 and 2023 (no data was collected in 2021). Ground based transect surveys for nests on the YKD in 2022 indicated about half the number of nests compared to recent plot-based surveys, suggesting that breeding effort or population size on the YKD has declined. The recovery criteria for spectacled eiders requires an increasing population in both Alaska breeding areas given the current estimated population size. The recent declines in breeding indices on the YKD and ACP are concerning, and push this species further from achieving recovery criteria. Causes of the recent decrease in breeding indices are unknown but may include reduced breeding propensity, population size, or changes in distribution.

Drivers of Annual Recruitment in Sea Duck Populations Revealed Using Harvest Surveys

Presented by: Jacob Hewitt (hewittj4114@gmail.com)

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Components of breeding productivity and survival rates in avian populations respond to dynamic environmental stressors across the annual cycle, which therein shape population dynamics over time. In sea ducks (tribe mergini), few studies have characterized the ecological factors that drive annual recruitment trends at the population level over time due to scarce scalable population information. Here, I leveraged historic harvest survey recruitment estimates (juvenile proportions) and indicators of environmental conditions at breeding, staging, and wintering areas from 1980-2017 to investigate factors influencing annual recruitment rates in eastern North American populations of long-tailed ducks (Clangula hyemalis), black scoters (Melanitta americana), white-winged scoters (M. delgandi) and surf scoters (M. perspicilatta). Recruitment rates in multiple species were positively associated with mean ambient temperatures at staging and breeding areas during spring. This supported my hypothesis that pre-nesting ice cover in key habitats limits breeding productivity by delaying breeding phenology and causing declines in female body condition. Surf scoter recruitment had a strong negative association with great gray owl irruptive migrations, suggesting surf scoters experience intensified predation pressure during low phases of vole population cycles and incur lower nest and brood survival rates. North Atlantic Oscillation patterns and staging area mean ambient temperatures in autumn showed associations with sea duck recruitment, suggesting harsh weather conditions post-fledging may precipitate early migratory movements that reduce juvenile survival rates or elicit greater proportions of adult sea ducks in subsequent harvests. My findings highlight important relationships between sea duck annual recruitment and ecological factors that may have considerable consequences for sea duck populations as ecosystems and climatic patterns undergo significant changes in the future.

Long-Term Population Trends of Wintering Waterfowl in the Mississippi Alluvial Valley

Presented by: Kara Hall (brian.davis@msstate.edu)

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Recently, literature has reported that mallard (Anas platyrhynchos) and other ducks are wintering farther northward in relation to increased winter temperatures, presumably from climate warming. The Mississippi Department of Wildlife, Fisheries, and Parks and Arkansas Game and Fish Commission have conducted line-transect, fixed-wing aerial surveys across their portion of the Mississippi Alluvial Valley (MAV) for nearly 20 years allowing us to estimate long-term population trends for a variety of wintering duck species, including mallards, gadwall (Mareca strepera), green-winged teal (Anas crecca), northern shoveler (Spatula clypeata), northern pintail (Anas acuta), and wood duck (Aix sponsa). We used data collected from aerial surveys, as well as from citizen science sources (e.g., Christmas Bird Counts), to examine long-term trends of these species in the Arkansas (2009-2021) and Mississippi (2002-2021) portions of the MAV. Christmas bird counts indicate that trends for each species were similar across states. While population numbers can vary widely from year to year, Arkansas and Mississippi have seen overall increases in gadwall, northern shoveler, and green-winged teal, with an average 5-6%, 2-3%, and 0-1% increase, respectively. In contrast, mallard, northern pintail, and wood duck abundances have remained relatively stable. Preliminary analyses of aerial transect data also follow these trends.

Using a Photo Survey to Estimate Annual Recruitment in Atlantic Flyway Sea Duck Populations

Presented by: Jacob Hewitt (hewittj4114@gmail.com)

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Sea duck (tribe mergini) populations in the Atlantic Flyway have experienced significant declines in recent years, though underlying causes are poorly understood. Information on population demographic parameters may provide insight for wildlife managers seeking to maintain sustainable harvest. However, population monitoring capacity for sea ducks is limited relative to other migratory bird species due to their remote breeding distribution. The U.S. Fish and Wildlife Service organizes a Parts Collection Survey (PCS) which estimates recruitment in sea duck populations using age ratios (juveniles/adult), though estimates are biased due to differential harvest vulnerability between age-cohorts. I used a direct-count photo survey to calculate improved estimates of annual recruitment for long-tailed duck, black scoter, surf scoter, and white-winged scoter (hereafter sea ducks) populations in the Atlantic Flyway. I and other surveyors collected photos of flighted sea ducks from shore and by boat in 11 states from October 15-December 15 annually in 2019-2022. We classified photographed birds according to age and sex and calculated juvenile proportions of each species using a Bayesian binomial model. To compare photo survey estimates with PCS estimates, I used a paired t-test organized by year. I found that PCS estimates of juvenile proportions were significantly greater than photo survey estimates for three sea duck species, indicating a consistent positive bias in PCS driven by harvest vulnerability. I also derived novel estimates of juvenile harvest vulnerability using the mean difference between within-year estimates. My work demonstrated the photo survey methodology used in this study produced reliable and precise annual recruitment estimates for four poorly monitored waterfowl populations; I recommend managers continue to adopt this approach in future years with additional consideration given for spatial representation and refinement of image classification procedures for long-tailed duck estimates.

Seasonal Abundance, Sex Ratio, and Survival of the Endangered Hawaiian Duck on North Kaua'i

Presented by: Christopher Malachowski (christopher.malachowski@colostate.edu)

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The Hawaiian Duck (or koloa maoli; Anas wyvilliana) is an endangered, non-migratory dabbling duck that experienced substantial population declines and range contraction during the 20th century. A critical obstacle in assessing threats and developing effective conservation plans involves the lack of information on population structure and demographic rates. Adult sex ratio is a key feature of population demography and has important implications for extinction risk, particularly for small populations. We used a 5-year capture-mark-recapture (CMR) dataset and robust design CMR models to estimate adult abundance, sex ratio, and survival of Hawaiian Ducks at Hanalei National Wildlife Refuge (NWR) on north Kaua‘i, Hawai‘i, USA. During 2010–2015, 792 Hawaiian Ducks (n = 150 females, n = 642 males) were captured 1,236 times. Model-averaged, sex-specific abundance estimates revealed a heavily distorted, male-biased sex ratio (3:1) that was relatively consistent across seasons and years. Annual apparent survival was lower for females (0.43) compared to males (0.69). We found strong evidence for the presence of temporary emigration, but the particular form of emigration (i.e., random vs. Markovian) was unclear. The top model suggested random temporary emigration varied on a seasonal basis, with a greater proportion of birds moving to an unavailable state during summer (0.76) compared to winter (0.64). Abundance estimates of Hawaiian Ducks at Hanalei NWR, a core wetlands site, varied from 252 to 625 adult and first-year birds (mean = 407); however, these estimates reflect the abundance of birds available for capture, which may underrepresent the total number of birds on the refuge. Our study provides estimates of several demographic parameters needed for improving our understanding of Hawaiian Duck population dynamics and informing future modeling efforts and conservation decisions.

Pitfalls in Bayesian Modeling of Band-Recovery Data

Presented by: Cody Deane (cdeane2@alaska.edu)

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Band-recovery data are the most common data type available for estimating annual survival of most North American waterfowl populations. Survival and harvest parameters estimated from these data are often considered when making harvest management decisions, and these data are increasingly analyzed within Bayesian estimation frameworks. Despite the increasing application of Bayesian band-recovery models to data for species of high management interest, there is a lack of rigorous assessments of contemporary modeling approaches for band-recovery data. Previous analyses of the midcontinent mallard (Anas platyrhynchos) population indicate within-year variation between direct (<1 year) and indirect (>1 year) recovery probabilities may be common, yet it is now common to model band-recovery data without accounting for heterogeneity between direct and indirect recoveries of adult waterfowl. A further consideration when fitting Bayesian models with time-varying random effects is the interaction between parameter shrinkage and the years included in an analysis. We summarize results from simulated and mallard band-recovery data indicating potential shortcomings in analyses of band-recovery data related to statistical power, unmodeled heterogeneity, and the time spans used in these analyses. Our results indicate the power to estimate annual variation in survival and harvest probabilities is low when using sample sizes like those available for species whose status is of high management priority. We also show that ignoring heterogeneity in band-recovery data can result in variable and inconsistent underestimation of juvenile and adult survival, even when the unmodeled heterogeneity is only present in adult recovery data. We then present results showing how inference about survival and harvest can depend on the years included or excluded from random effects structures. Together, our results indicate our current understanding of the drivers of waterfowl population dynamics may be limited by a current lack of attention to seemingly nuanced details when fitting Bayesian models to band-recovery data.

Landscape Genetics Reveals Environmental Drivers of Historical Reproductive Barriers Between Mexican Ducks and Mallards

Presented by: Joshua Brown (jbrown@wtamu.edu)

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Little is known about the evolutionary history of the Chihuahuan desert endemic Mexican duck (Anas platyrhynchos diazi), which is one of four mallard complex species within North America. Hybridization with mallards (A. platyrhynchos) was originally thought to be a major conservation concern for Mexican ducks, but recent molecular work suggests otherwise. Here, we use ddRAD-seq from range-wide samples to shed light into the divergence process of these two closely related species. By integrating demographic and genotype-environment association (GEA) modelling, we were able to parse out the role of environmental selective pressures in driving the development reproductive barriers. First, evolutionary models and demographic analyses support the hypothesis that Mexican ducks originally diverged ~300,000 years ago in a climate refugia arising during a glacial period in southwestern North America. Subsequent environmental conditions likely played a key role in divergence, leading to strong partitioning in the adaptive space of Mexican ducks and mallards in GEA models. Next, Mexican ducks showed cyclical demographic patterns that likely reflected repeated range expansions and contractions, along with bouts of hybridization with mallards during glacial cycles. Given that pre-zygotic breeding barriers are generally slow to develop, strong ecological barriers being driven by strong selective pressures likely acted to prevent genetic swamping during periods of secondary contact. Finally, models project that Mexican ducks will be at risk under future climate conditions, as habitat is likely to be lost and fragmented due to drier conditions. Overall, this work reveals that the genomic and phenotypic patterns observed across the mallard complex are the result of myriad factors that contribute in dynamic ways to its evolutionary history and current conservation status.

Estimating Future Densities and Distributions of Breeding Duck Pairs Under a Changing Climate in the U.S. Prairie Pothole Region

Presented by: Aaron Pearse (apearse@usgs.gov)

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The Prairie Pothole Region (PPR) is a key breeding area supporting migratory waterfowl in North America. Tens of millions of dollars are invested annually to conserve and enhance upland and wetland habitats for breeding ducks by prioritizing locations predicted to have high densities of breeding pairs under average precipitation conditions. An implicit assumption of this approach is that the distribution of breeding habitat remains relatively static. Climate change is an identified risk to this strategy. To assess this assumption and plan for potential forthcoming conditions, we estimated changes in potential breeding duck pairs under different climate scenarios by combining results of 1) a mechanistic hydrology model that simulates ecosystem processes for a subset of wetlands distributed across the U.S. PPR; 2) four downscaled climate model projections at mid- and late-century time horizons; and 3) U.S. Fish and Wildlife Service multi-decadal datasets and predictive breeding waterfowl pair statistical models. Wide-spread reduction size of surface water and potential pair densities were evident for most climate scenarios and time horizons, with the magnitude of loss generally greatest in southern and western portions of the Dakotas. As expected, future scenarios with greater emissions (resulting in warmer temperatures) predicted the lowest pair densities. For all climate scenarios, predictions at the end of the 21st century expressed more extreme reductions in potential breeding duck pair abundances compared to mid-century predictions. Information from these robust predictions of waterfowl habitat and settling patterns in this region provides land-management agencies insights in prioritizing current conservation actions given uncertainty. In addition, understanding how many breeding pairs the U.S. PPR might support in coming decades will likely influence overall breeding population sizes and sustainable harvest objectives across North America.

Uncovering Habitat Associations and Thresholds for Breeding Waterfowl in Eastern Canada: Using Species Abundance Models to Prioritize Habitat for Conservation and Restoration

Presented by: Amelia Cox (amelia.cox@ec.gc.ca)

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Through NAWMP, waterfowl are central to wetland conservation and restoration programs in Canada, but habitat features that provide high quality waterfowl breeding habitat in eastern Canada are complex and often non-linear, making prioritization of wetland habitat delivery challenging for conservation partners. Here, we used data collected through four concurrent breeding pair surveys conducted by helicopter from 2001–2015 to develop generalized additive models of abundance for 17 waterfowl and waterbird species. This approach allowed us to better understand how habitat influences breeding density and distribution in eastern Canada and identify habitat thresholds for each species. We used predictive mapping to identify areas of high density and identify priority areas for conservation action by the Eastern Habitat Joint Venture (EHJV), as well as habitat thresholds to identify areas where prioritizing restoration of wetlands would increase the breeding density of five wetland associated waterfowl species prioritized by the EHJV for conservation action. Habitat associations and spatial density patterns varied across species, but general trends suggest waterfowl breeding density is strongly related to forest composition, agriculture, and wetland features. Habitat thresholds were common; for most waterfowl species, the positive effect of increasing wetland cover on breeding density diminished once 14% of the 5 km x 5 km study plot consisted of wetlands. Targeting EHJV investments in increasing wetland area along the Québec St. Lawrence Valley, and in the agricultural mixed wood landscapes of New Brunswick, Nova Scotia and Prince Edward Island would have the largest impact on breeding waterfowl densities. Wetland enhancement programs targeted at these regions would provide the best opportunities to increase breeding densities for EHJV priority waterfowl species.

Breeding Duck Pair Densities: Insights from the Prairie Pothole Region of Central Saskatchewan, Canada

Presented by: Hannah Sabatier (hannah.sabatier@outlook.com)

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Successfully hatching a clutch is a vital component of recruitment in duck populations, and it partly depends on when and where a nest is initiated. Specifically, ducks are attracted to environments with intact grassland and interspersed wetlands. If nest site selection is adaptive and ducks select nest sites based on areas with high-quality habitat, we predict there will be a positive relationship between habitat quality and duck breeding pair density (BPD) in these
areas. However, there are also other factors that might influence how pairs select habitat, including mammalian densities and grassland health. Therefore, we examined how pond density and grassland health affected BPD in the prairie pothole region of Central Saskatchewan, Canada. Further, we experimentally controlled mammalian predator communities and evaluated associated effects on BPD. We collected pair density data using Unmanned Arial Vehicles across six 5 mi2 study blocks arranged in a randomized block design with 3 mammalian predator trapping treatments blocks and 3 control blocks. We flew surveys over a sample of approximately 30 quarter sections per block. We hypothesized that 1) BPD would have a positive relationship with intact grassland and high pond densities and 2) BPD would have a positive relationship with grassland health and sites where land use remains as grassland. Understanding the drivers of BPD is crucial for conservation efforts and wildlife management. It can inform land use planning and conservation strategies to continue to support duck populations in the future.

Conspecific Brood Parasitism in Red-Breasted Mergansers: Parasite Behavior and Host Fitness Costs

Presented by: Shawn Craik (shawn.craik@usainteanne.ca)

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Conspecific brood parasitism (CBP) is an intriguing alternative reproductive tactic that is especially common in waterfowl. Nonetheless, demographic studies of CBP are known for only a few species, so we still do not fully comprehend the adaptative significance of CBP across ecological contexts in which the behavior occurs. CBP is an important, yet relatively unexplored feature of the nesting biology of Red-breasted Mergansers (Mergus serrator). We assessed (i) cues used by parasites for selecting host nests and (ii) effects of CBP on host lifetime fitness in a colony of Red-breasted Mergansers in which nests are placed in dense upland vegetation on a coastal archipelago. Brood parasites did not select host nests based on traits providing cues about nest-site safety or host quality. Rather, natural nests were much more likely to be parasitized than experimental nests, suggesting that host presence can act as a cue for parasites looking to lay their foreign eggs. Parasitic eggs were almost always laid during the host laying cycle and typically in nests initiated early in the season. Indeed, rates of parasitism throughout a host's lifetime (range 0-100% of nests) increased with earlier dates of nest initiation. CBP was not linked to annual survival in hosts, however, we detected measurable costs of brood parasitism to hosts' current reproduction. Hatching success throughout a host's lifetime declined with a greater number of foreign eggs added to the individual's nests. Despite this, hosts spent little time at the nest prior to incubation and did not remove parasite eggs immediately after being laid. The lack of strong host defense against CBP may reflect in part weak selection pressure given that host fitness costs of parasitism in this population were apparently small for nests with light parasitism (e.g., 1-3 foreign eggs).

Factors Affecting Cause-Specific Egg Mortality in a Host-Parasite-Predator System

Presented by: Michael Johnson (mk.johnson@colostate.edu)

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Facultative brood parasitism is a common breeding strategy among North American waterfowl species that aims to salvage or increase an individual's reproductive success, and has been linked to both experience and the availability of suitable nesting sites. Conversely, the consequences sustained by the host include egg loss, reduced hatchability, nest abandonment, and perhaps even increased cues provided to visual predators. Instances of interspecific brood parasitism are common among over-water nesting ducks and no host-parasite relationship has garnered more attention than canvasbacks and redheads where parasitic female redheads seek out and infiltrate canvasback nests to lay eggs. We monitored parasitized and unparasitized canvasback nests from 2016-2020 near Minnedosa, Manitoba, and recorded the fates of 3750 canvasback eggs presumed to be part of the host's clutch. Using a multinomial logistic-exposure modelling approach in a Bayesian framework, we assessed competing sources of egg mortality as they related to brood parasitism (i.e., egg displacement), abandonment, and predation, to address whether mortality pressures were compensatory or additive, and correlated with local nesting habitat conditions. Host clutch sizes were smaller in parasitized versus unparasitized canvasback nests and cause-specific mortality estimates showed consistent additive impacts of brood parasitism regardless of local nesting conditions. These results suggest that nesting canvasback near Minnedosa are experiencing consistent and unprecedented rates of parasitic pressure, leading to lower reproductive output with possible consequences for population dynamics.

NOAA Firebird: Fire Effects in Gulf of Mexico Marshes on Mottled Ducks, Black and Yellow Rails

Presented by: Auriel Fournier (auriel@illinois.edu)

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C. Butler, Texas A&M University
W. Cheney, U.S. Geological Survey Contractor
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J. Cox, Tall Timbers
N. Enwright, U.S. Geological Survey
K. Evans, Mississippi State University
E. Johnson, Audubon Delta
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J. Lancaster, Gulf Coast Joint Venture
H. Levy, Tall Timbers
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J.E. Lyons, U.S. Geological Survey
L. Monopoli, University Illinois
J. Moon, U.S. Fish and Wildlife Service
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Although extensive work has been done in upland systems to understand the role of fire in maintaining ecosystem functions, little has been done on the maintenance of coastal wetlands, or the response of birds in high marsh wetlands. High marsh is a unique habitat type, imminently threatened by sea level rise and characterized by a community of specialized emergent vegetation that tolerates irregular tidal inundation. Land managers' decisions about prescribed fire in high marsh systems are complicated by uncertainty around the response of birds to the application of prescribed fire. Without an understanding of how prescribed fire impacts high marsh ecosystems, natural resource managers will be limited in our ability to manage and conserve the biodiversity of the Gulf Coast. Black rail, yellow rail, and mottled duck are birds of concern, and uncertainty currently limits the application of prescribed fire for the benefit for all three species. We will present our work to date in monitoring the response of our three focal species to

prescribed fire management of their habitats, and what we've learned along the way in terms of sampling design for three birds that can be challenging to study.

Fire for Feathers- Assessing the Impacts of Fire on Breeding Mottled Ducks

Presented by: Pierce Adams (pierce.adams@ttu.edu)

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The coastal prairies and marshes of the Gulf Coast are fire-adapted ecosystems, where fire is a critical driver of the regional disturbance regime that has shaped plant and animal communities. Mottled ducks (Anas fulvigula) have co-evolved with fire in this geography, but little research exists on how both prescribed and wildland fire impacts mottled duck habitat use. Our study combines five mottled duck telemetry datasets (Rigby 2008, Wheland 2012, Davis 2012, Moon 2014, and Bonczek 2022) that will address two questions: (1) How important are irregularly flooded wetlands to breeding mottled ducks? and (2) How does the fire return interval, time since fire, and other fire characteristics influence mottled duck selection in high marsh and other important habitats (e.g., fresh and intermediate coastal marsh, wet coastal prairie)? To assess objective 1, we will update the 2010 mottled duck breeding habitat model produced by Moon et al. (2021) and include the irregularly flooded wetland layer produced by Enwright et al. (2022) as a covariate. To assess objective 2, we will use the updated breeding habitat model, combined with fire coverages produced by Vanderhoof et al. (2022) to quantify how prescribed and wildfire has affected mottled duck habitat use. With special focus upon how time since fire affects site-specific use and selection, this research will identify appropriate burn rotations for mottled ducks across a variety of habitats throughout the Gulf Coast. This research project will provide practitioners and land managers information on how to apply fire to positively influence mottled duck breeding ecology.

Boreal Duck Reproductive Success: Relationships with Breeding Pair Density, Spring Phenology and Predator-Prey Dynamics

Presented by: Kyla Bas (k_bas@ducks.ca)

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R.G. Clark, Science & Technology Branch, Environment and Climate Change Canada

Population dynamics of ducks breeding in the North American boreal forest are influenced by factors affecting breeding success and recruitment of juveniles, but relatively few studies have evaluated how environmental factors impinge on duck productivity in boreal systems. Using 26 years of breeding survey data for five duck species at a boreal site, I evaluated annual variation in brood abundance relative to breeding pair density, local spring phenology and weather conditions, and abundances of predator and staple prey species. There was weak evidence of negative density dependence in productivity, driven primarily by mallard (Anas platyrhynchos), as the slope of the relationship between brood abundance and indicated breeding pairs for all species combined was lower than expected (<1:1 ratio). No relationship was found between indices of spring phenology and brood abundance in any duck species. Brood abundance was positively related to favourable weather conditions during the early breeding season for mallard and American wigeon (Mareca americana). Brood abundance was higher at intermediate levels of the small mammal abundance index. A negative relationship was detected between brood abundance and hare density in the current and previous years in all species and was strongest in scaup (Aythya affinis). Key predators of snowshoe hare (Lepus americanus) likely are prey-sharing when snowshoe hares are abundant, preying on ducks as well. There was no direct effect of fox (Vulpes vulpes) abundance on duck productivity, and lynx (Lynx canadensis) abundance had a weak negative relationship with brood abundance. While future duck production might not be adversely affected by a warming climate, reproductive success will also depend critically on the dynamic interplay between future climatic conditions, wetland resources, and predator-prey cycles.

Nest Box Selection by Common Goldeneye (Bucephela clangula) in the Chena River System, Interior Alaska

Presented by: Riley Porter (rdp275@msstate.edu)

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E. Taylor, Bureau of Ocean Energy Management

The Common Goldeneye (Bucephala clangula) is a cavity nesting sea duck that predominately breeds in boreal forest systems. Goldeneyes spend 7-8 months of their annual cycle in both freshwater and marine environments but subsequently return inland to freshwater habitats to breed. Artificial nest boxes are used to increase breeding populations of goldeneyes and other waterfowl in Europe and North America. In 1993, the University of Alaska Student Chapter of The Wildlife Society received funding from Ducks Unlimited to assess nesting ecology of common goldeneyes at the northern limit of their breeding range. Starting in 1997, 150 nest boxes were deployed in the 639 km2 Chena River State Recreation Area, located approximately 48 km northeast of Fairbanks, Alaska. Although productivity, duckling survival, nest attendance and other aspects of common goldeneye breeding ecology have been reported, no information exists on how environmental variables may potentially impact goldeneyes' choice of nest boxes. Because approximately 30% of the boxes have remained unoccupied since 2005, we assess how resource characteristics at various scales influence nest box selection by breeding goldeneyes. Here, we report on how distance to nearest occupied nest box, nest box visibility, and other factors potentially influence nesting site selection. Results of this study will increase our understanding of nest site selection at multiple scales to better evaluate boreal wetland habitats for this species in interior Alaska.

Evaluating the Mottled Duck Nest Predator Community in Southwest Louisiana Using Camera Traps and Artificial Nests

Presented by: Alexandre Dopkin (adopki1@lsu.edu)

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The Mottled Duck (Anas fulvigula) population in Louisiana declined by more than two thirds between 2011 and 2021. Predation of eggs is the most frequent cause of Mottled Duck nest failures, yet the composition of the Mottled Duck nest predator community in Louisiana is poorly known. To address this knowledge gap, from March–July in 2021 and 2022 we deployed 419 artificial nests, 212 of which were monitored by trail cameras, to identify important nest predators, index predator activity, and estimate the relative risk predators pose to Mottled Duck nests in important breeding habitats (upland, cutgrass marsh, cordgrass meadows, and terraces). Camera footage documented an astonishing diversity of nest predators: American mink (Neovison vison), common raccoon (Procyon lotor), Virginia opossum (Didelphis virginiana), coyote (Canis latrans), American alligator (Alligator mississippiensis), western ratsnake (Pantherophis obsoletus), American Crow (Corvus brachyrhynchos), grackles (Quiscalus spp.), Clapper Rail (Rallus criptans), King Rail (Rallus elegans), and Purple Gallinule (Porphyrio martinicus) were all observed to depredate simulated nests. Mixed-effects Cox regression models from 2022 indicate that specific predator species pose the highest risk to nest survival, with hazard ratios of 9.9 for mink, 5.1 for alligator, 3.9 for opossum, and 3.4 for raccoon. Cameras documented mink on 4/7 cordgrass replicates, 1/7 cutgrass replicates, and 1/6 terrace replicates. Alligators were observed on 2/7 cutgrass and 3/6 terrace replicates. Notably, mink and alligator, the two most hazardous nest predators, were never documented on upland nesting grounds, the most commonly utilized nesting habitat by Mottled Ducks. Raccoons were observed on 3/7 cordgrass, 1/7 cutgrass, 2/7 terrace, and 1/7 upland replicates. Opossums were documented on 2/7 cutgrass and 3/7 upland replicates. This information directly supports efforts to better understand causes of Mottled Duck nest failure, and how the severity of nest depredations may be contributing to the decline of Louisiana Mottled Ducks.

Vegetation and Waterbird Response to a Drawdown on a Semi-Permanent Wetland

Presented by: Katherina Schroyer (ks047428@uamont.edu)

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Big Lake National Wildlife Refuge (NWR) is a wetland complex in northeast Arkansas composed of seasonally and semi-permanently flooded areas with floating-leaf aquatic vegetation, scrub-shrub and floodplain forest, open water, and emergent vegetation. Big Lake NWR has open water areas that are currently dominated by American Lotus (Nelumbo lutea). Therefore, Big Lake NWR requires periodic drawdowns to consolidate sediments, control invasive species, and allow active management activities. We monitored the response of waterfowl and waterbirds, vegetation communities, and soil compaction to the drawdown of Big Lake NWR during 2022–2024. We created a land cover classification model using 3x3 meter resolution PlanetScope imagery to monitor monthly and yearly changes in the observed vegetation communities from Jun-Nov 2021–2023. We estimated the coverage of forest, open water, bare ground, floating leaf aquatic, non-persistent emergent, and persistent emergent vegetation before and following the drawdown. Estimates of coverage by each vegetation community type were used to predict energetic carrying capacity (i.e., waterfowl energy days) pre- and post-drawdown to evaluate performance relative to objectives for the refuge and the region. Aerial surveys for waterfowl and waterbirds were conducted from November – February, and migration curves were developed to compare estimated waterfowl abundance in 2022 and 2023 to a standardized eBird migration curve. We developed a depletion model for food energy to predict the relationship between supply and demand. Collectively, these tools will help refuge staff in other areas with similar vegetation communities better understand the effects of management practices across the landscape on meeting habitat objectives for waterfowl and waterbirds.

Will Semipermanent Wetlands Be the Bottleneck for Production in the Future Duck Factory?

Presented by: Michael Anteau (manteau@usgs.gov)

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The Prairie Pothole Region (PPR), aka “Duck Factory”, annually hosts breeding efforts of over half of North American counted ducks. The region’s importance in supporting duck populations is attributed to complexes of wetlands of various hydroperiod within a grassland matrix. Conversion of grassland to cropland and drainage of wetlands has drastically modified portions of this landscape and has reduced the capacity of the duck factory to produce ducks. This has motivated conservation actions focused on protecting grasslands from conversion and wetlands from drainage. Wetland conservation has focused on temporary and seasonal wetlands, the most vulnerable to drainage and important habitat for ducks during the early parts of the breeding season. While semipermanent wetlands are critically important for brood rearing and molting habitat late in the breeding season, they receive less conservation attention due to the perception they are safer from drainage. Through several lines of research, we have observed an alarming trend of hydrologic shifts in wetlands of the PPR which generally can be characterized as the lakeification of semipermanent wetlands. Semipermanent wetlands are getting deeper, drawing down less frequently, and becoming dominated with invasive fish or cattail making them far less useful late summer habitat for ducks. This process has been mediated by a synergism between climate and land use changes in the region which act specifically on longer hydroperiod wetlands. Importantly, we see no evidence of shorter hydroperiod wetlands shifting into semipermanent wetlands, which suggests losses in diversity and resiliency of hydrologic regimes in the PPR. We will synthesize findings of recently published and ongoing work that explore mechanisms driving this pattern. We will also provide context on how conservation strategies might need to broaden, assuming that it is a priority to ensure semipermanent wetlands can provide brood rearing and molting habitat in the future PPR.

Preferred Atmospheric Circulations Associated with Favorable Prescribed Burns in the Gulf of Mexico, U.S.A.

Presented by: Auriel Fournier (auriel@illinois.edu)

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Application of prescribed fire in natural plant communities is an important wildlife habitat management tool. Prescribed fire managers have suggested anecdotally that changing weather patterns may be influencing the frequency of days that have optimal conditions to conduct coastal marsh burns along the US Gulf of Mexico coast. Our study objectives were to (1) determine whether the frequency of atmospheric circulation patterns associated with prescribed fire prescriptions has changed from 1979 to 2018 for the Gulf Coast and (2) identify circulation patterns preferred by land managers for implementing prescribed fire.

Assessment of Seasonal Wetland Availability to Inform Non-Breeding Waterfowl Conservation on the Western Gulf Coast

Presented by: Joe Lancaster (jlancaster@ducks.org)

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The U.S. Western Gulf Coast, which corresponds to the planning region for the Gulf Coast Joint Venture (GCJV), provides important habitat for migrating and wintering waterfowl. The GCJV uses bioenergetic models that incorporate species-specific population abundance objectives, temporal residency, energy demand of birds, and foraging values of habitats to translate winter waterfowl population targets into habitat objectives for this important region. These objectives are expected to represent landscape conditions needed to support waterfowl populations at levels that are aligned with continental objectives of the North American Waterfowl Management Plan (NAWMP). Periodic assessments of long-term trends and annual variation in landscape conditions are necessary for evaluating progress toward objectives and ensuring established conservation priorities remain appropriate. Since 2010, the GCJV has used remotely sensed imagery (e.g., Landsat) to quantify abundance of winter waterfowl habitat on inland agricultural lands of the U.S. Western Gulf Coast during three periods of its autumn-winter planning window. The GCJV has quantified winter habitat abundance for 37 winters (1985–2022), revealing significant inter- and intra-annual variation in habitat abundance within and among Initiative Area planning regions. The availability of non-tidal freshwater wetlands exceeded regional habitat objectives in 48–82% of autumn periods (16 August–31 October) assessed and 22–100% of winter periods (1 November–31 March) assessed. These data shed important light on spatial and temporal variation in waterfowl habitat across the GCJV landscape, help elucidate the effects of human activities and environmental conditions on landscape-scale waterfowl habitat abundance, and offer a new context within which to examine and interpret progress toward NAWMP habitat objectives. This presentation will discuss the methodology, results, and how targeted wetland enhancement through partnership programs like the Texas Prairie Wetlands Project contribute to achieving GCJV non-breeding waterfowl habitat objectives.

Revisiting the 2020 Vision of Wetland Habitats and Waterfowl: How Good Were the Predictions?

Presented by: David Olson (dave_olson@fws.gov)

D. Olson, U.S. Fish and Wildlife Service

There was a collection of papers presented at the 53rd Midwest Fish and Wildlife Conference in Des Moines, IA in 1991. A paper was presented by Dave Sharp and Robert I. Smith, both from the U.S. Fish and Wildlife Service, Office of Migratory Bird Management, entitled Wetland Habitats and Waterfowl in 2020: An International Conservation Challenge. The paper used recent estimates of wetland conversions and systematic waterfowl population surveys to determine trends and project status of these natural resources into the 21st century. The timeline for the data started in 1955 and finished in 1990 and then trend lines were projected 30 years to determine what would be the outcome in 2020. Data sets included 1. Wetland trends based on acres of wetlands and the theoretical trends in the U.S., 2. Breeding population trends for 10 principal duck species from the May Survey and the theoretical trends of those breeding populations, 3. Population trends for selected Canada goose, snow goose, white-fronted goose and brand populations surveyed during winter, 4. Populations trends for the Eastern and Western Tundra Swan Populations, and 5. Trends in Duck Stamp sales in the U.S. and Migratory Bird Hunting Permit sales in Canada. My paper assessed each one of these data sets and their predicted trends to 2020 by comparing the trend lines from the authors to the ones generated with updated data sets. The 1955-1990 waterfowl breeding population trend had a downward trend, however, when actual data was added, the 2020 outcome had an upward slope. When trend lines are added to data for future information needs, it may not always predict what happened. Monitoring programs provide a vital function so that data sets are updated with the latest information to assess, with greater confidence, what the estimated population may be.

When Is the Table Set? Important Considerations for How We Assess Wetland Seed Abundance

Presented by: Dan Smith (dsmith@ducks.org)

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Declining populations of wintering waterfowl in some regions may be driven by a lack of food resources. Efforts to recover threatened and endangered species within Suisun Marsh, California–through the conversion of managed wetlands to tidal marsh–could potentially exacerbate the decline of waterfowl by inadvertently reducing the abundance or availability of waterfowl food resources. To determine if wintering waterfowl populations were limited by food resources we addressed three questions: (1) what are the availability of seeds commonly consumed by waterfowl in tidal and managed wetlands, (2) how do wetland habitat and management factors influence the production of seeds, and (3) how does seed abundance decline over time due to decomposition and depletion by waterfowl? We found seed abundance in both wetland types was much lower than previously predicted and spatial variation in seed abundance was substantial. The species composition of seeds differed according to wetland type; over 75% of aggregate seed mass in managed wetlands was comprised of seed species that waterfowl consume, whereas a non-preferred food (Schoenoplectus sp.) was the dominant seed in tidal marshes. Habitat zone, defined by shared physical factors known to impact vegetation growth and production, was the best predictor of total seed abundance in managed wetlands. Using small-scale sampling sites and foraging exclosures stratified into high and low waterfowl use areas, we found seed abundance increased during the three weeks post-flooding, and over seven to ten weeks in foraging exclosures. Seed removal attributable to waterfowl was spatially variable and was correlated with waterfowl use; high use areas had significantly higher rates of seed depletion. Overall, bioenergetic models indicate limited food resources are preventing Suisun Marsh from reaching NAWMP population objectives. Furthermore, without accounting for seed removal by waterfowl and hydrochory, bioenergetic models may produce inaccurate estimates of habitat carrying capacity.

Waterfowl and Water Quality: How Comparing Wetland Restorations Can Help Build Up Wetland Multifunctionality

Presented by: Evangelin Von Boeckman (erv224@iastate.edu)

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Wetland restoration is a fundamental tool to meet state, region, and nation-wide objectives for wetland bird conservation and improving water quality through nutrient reduction. Restorations and associated funding mechanisms typically seek to accomplish one of these overarching goals and tradeoffs with other ecosystem functions remaining largely undocumented. We sought to formally evaluate these potential tradeoffs and inform future design by comparing bird use between wetland restorations with a first-order priority for wildlife habitat with those with a first-order priority for water quality. We drew a paired random sample of 23 water quality wetlands (WQW) and 23 wildlife wetlands (WW) within 12 miles of one another in the Prairie Pothole Region of Iowa. We conducted secretive marsh bird surveys, waterfowl brood drone surveys, fish trapping, vegetation surveys, and water sampling during summers 2022 and 2023. In 2022, WW had more secretive marsh birds (357 individuals from 10 species, 57%) than WQW (266 individuals from 10 species, 43%) for all species except American Bittern. WQW contained 60% of all broods detected and had larger numbers of wood ducks (70%) on WQW and mallards (60%). WQW were more likely to have fish (78%) than WW (30%). Our study emphasizes that wetland restorations have capabilities to meet multiple objectives, with potential for improving current design and management of wetland restorations. Understanding potential functions of restorations can provide managers, restorationists, and biologists ways to collaborate, meet many, crucial objectives, and contribute to the knowledge of wetland multifunctionality.

Abiotic Factors Affecting Bottomland Hardwood Tree Establishment on Restored Wetlands in Western Kentucky and Tennessee

Presented by: David Hicks (dhicks@ducks.org)

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Approximately 75% of bottomland hardwood forests in the Lower Mississippi Alluvial Valley (LMAV) have been converted to alternative land uses. The Wetlands Reserve Easement Program (WREP) accounts for the majority of private land forest restoration in the LMAV, but consistent ecological monitoring is often not feasible after restoration activities are complete. To assess forest restoration practices employed by the WREP on prior bottomland hardwood forests that were converted for agriculture, we quantified tree community metrics in three forest types: tree plantings on WREP sites, remnant forests on WREP, and reference forests on public land within the same watersheds as our study sites. We surveyed 46 study sites in fall of 2019 and 2020 to determine forest composition and assessed survival of trees planted during restoration activities. We calculated the Importance Value of each tree species to determine which species most contributed to overall forest composition in each forest type. Using nMDS ordination and post-hoc pairwise tests we compared community composition among the three forest types and found that restored forests varied from both remnant ($F = 3.94$, $p < .003$) and reference ($F = 3.03$, $p < .02$) forests. We also evaluated the survival of planted trees in relation to environmental factors using a generalized linear mixed model. Planted tree survival was lower in hydric compared to non-hydric soils ($\beta=-0.49$, $se=0.08$, $p<0.001$) and negatively associated with co-occurring tree density($\beta=-1.06$, $se=0.06$, $p<.001$) and elevation relative to stream drainage ($\beta=-0.19$, $se=0.02$, $p<0.001$. Planted tree survival increased with sapling density ($\beta=.09$, $se=0.03$, $p<0.001$) and distance from the nearest forest patch ($\beta=0.16$, $se=0.04$, $p<0.001$). To increase survival of planted trees, restoration practitioners may want to consider forest management practices that thin planted stands if there is abundant volunteer regeneration and evaluate site hydrology prior to selecting which tree species to plant during restoration efforts.

The Meaning of Wild: Genetic and Adaptive Consequences from Large-Scale Releases of Domestic Mallards

Presented by: Philip Lavretsky (plavretsky@utep.edu)

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The translocation of individuals around the world is leading to rising incidences of anthropogenic hybridization, particularly between domestic and wild congeners. We apply a landscape genomics approach for thousands of mallard (Anas platyrhynchos) samples across continental and island populations to determine the result of over a century of supplementation of practices. We establish that a single domestic game-farm mallard breed is the source for contemporary release programs in Eurasia and North America, as well as for established feral populations in New Zealand and Hawaii. In particular, we identify central Europe and eastern North America as epicenters of ongoing anthropogenic hybridization and conclude that the release of game-farm mallards continues to affect the genetic integrity of wild mallards. Focusing on North America, metapopulation dynamics across the Atlantic and Mississippi flyway are reported, with high rates of hybridization predictably in regions of ongoing game-farm mallard releases. Importantly, we report that these interactions are impacting morphological and behavioral traits that are highly linked to important life-history traits of wild mallards (i.e., feeding, migrating). Together, we report that a century of game-farm mallard releases not only fundamentally transformed North America's wild mallard genetic ancestry, but that such interactions are having direct impacts to the adaptive qualities of individuals. Given the often-resulting need for continued stocking in wild populations that have been supplemented for generations, it is essential we monitor and understand consequences of these ongoing interactions on fecundity and fidelity of wild mallard populations.

Reconstructing the Genomic and Morphological History of Wild Mallards Resulting from Game-Farm Mallard Releases

Presented by: Lauren McFarland (lmcfarland@miners.utep.edu)

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Recent landscape genomic studies have concluded that a century of releasing captive-bred, game-farm mallards (Anas platyrhynchos domesticus) resulted in geographically widespread introgressive hybridization that fundamentally changed the genetic ancestry of North America's wild mallard populations. Predictably, the domestication process resulted in significant genetic differences between game-farm and wild mallards; however more importantly, these molecular differences translate to morphological and behavioral traits that may negatively affect fecundity and survival when subjected to wild settings. While we have a contemporary understanding about when and how many game-farm mallards are released to supplement populations, our study aims to reconstruct the genetic and morphological consequences from this history across time and space. To do so, we take advantage of the deep historical sampling of mallards that are deposited across national natural history museums dating before (pre-1920) and after major game-farm mallard releases occurred in North America. We assessed genetic ancestry as well as determined bill morphology using 3D scanning technology for ~800 museum samples spanning across North America and collected from 1800-2022. We tested whether contemporary genetic and morphological differences were the result of a single swamping event, occurring over multiple bouts of contact, or resulted from continuous and additive affects through time. Preliminary analyses demonstrate that indeed game-farm and wild mallards differ in bill shape and volume, as well as lamellar density, and that these features show intermediacy across game-farm × wild mallard hybrids. Ultimately, this study will not only shed light on the mode of hybridization but mechanistic consequences regarding overall bill shape and feeding efficiency that these releases have had on wild mallard populations. Understanding the effects supplemental stockings have on wild populations is vital to the future of mallard conservation.

Game-Farm Mallard Releases Lead to Hybridization and Pose a Threat to the Genetic Health and Future Adaptive Potential of Wild Populations Across North America

Presented by: Joshua Brown (jbrown@wtamu.edu)

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P. Lavretsky, Department of Biological Sciences, University of Texas at El Paso

Prior to the 1800's, mallards (Anas platyrhynchos) were seldom seen in Atlantic flyway states. However, mallards quickly became one of the most common waterfowl species in the region due to changes in management practices, specifically, game-farm mallard releases. Recent research confirms that wild and game-farm mallards have been hybridizing in areas where they overlap. Introgression of maladaptive genes could be playing a role in the recent declines seen in eastern mallard populations. Here, we use ddRAD-seq of a range-wide sampling of mallards in North America to determine whether any maladaptive game-farm traits are contributing to the decline of eastern populations. First, we find that Atlantic flyway mallards constitute a hybrid swarm, as ~98% of samples collected in this region had significant game-farm ancestry. This represents a 4-fold decrease in the prevalence of pure wild mallards over the last 10 years. Next, we use genotype-environment association modelling to show that wild and game-farm mallards have differing relationships to environmental selective pressures. Moreover, contemporary climate conditions are likely limiting the expansion of game-farm mallards, as significant genotypic turnover across the southern Canadian border is likely acting as a barrier to dispersal. Modelling under future climate conditions, we show that game-farm mallards are likely to find an expanded adaptive breeding space as temperatures warm, especially since this group is most strongly affected by winter weather conditions. Broadly, these data demonstrate that the relationship between selection, gene flow, and the environment has a complex effect on fitness. Additionally, these results demonstrate the importance of understanding the potential consequences of anthropogenic hybridization caused by captive-bred release programs.

Morphology and Food Intake Rate of Wild and Game-Farm Mallards

Presented by: Susannah Halligan (susannahhalligan@gmail.com)

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Large-scale releases of domesticated, game-farm Mallards to supplement wild populations have resulted in wide-spread introgressive hybridization that changed the genetic constitution of wild populations in eastern North America. The resulting gene flow is well-documented between game-farm and wild Mallards, but the mechanistic consequences from such interactions remain unknown in North America. We provide the first study to characterize and investigate potential differences in morphology between genetically known, wild and game-farm Mallards in North America. Concurrently, we studied feeding rates of wild-caught and game-farm mallards in a captive study because it was previously determined that their bill morphology differed in ways that may affect foraging. We used nine morphological measurements to discriminate between wild and game-farm Mallards at 96% accuracy. Compared to their wild counterparts, game-farm Mallards had longer bodies and tarsi, shorter heads and wings, and shorter, wider, and taller bills. The nail on the end of the bill of game-farm Mallards was longer, and game-farm Mallard bills had a greater lamellae:bill length ratio than wild Mallards. Moreover, wild-caught mallards ingested food at 52% greater rate than game-farm mallards. We provided the range of food sizes available to mallards in the wild and detected that game-farm mallards ingested food at about half the rate of wild mallards. We posit that 1) game-farm Mallards have diverged from their wild ancestral traits of flying and filter feeding towards becoming optimized to run and peck for food; 2) game-farm morphological traits optimized over the last 400 years in domestic environments are likely to be maladaptive in the wild; and 3) the introgression of such traits into wild populations is likely to reduce fitness. Understanding effects of game-farm Mallard introgression requires analysis of various game-farm × wild hybrid generations to determine how domestically-derived traits persist or diminish with each generation.

Comparisons of Morphology and Feather Patterns Among Genotypes of North American Mallards

Presented by: Hunter Collins (hcolli01@syr.edu)

H. Collins, SUNY College of Environmental Science and Forestry
M. Schummer, SUNY College of Environmental Science and Forestry
P. Lavretsky, University of Texas at El Paso
J. Simpson, Winous Point Marsh Conservancy

Over the last 20 years, the Mallard (Anas platyrhynchos) population in the eastern United States has declined by approximately 50% while other regional Mallard populations have been stable or growing. The release of game-farm mallards is a plausible reason for observed declines in the eastern Mallard population. Introgression of game-farm genes into wild Mallards translates to lower survival and fecundity. Currently, we are unable to differentiate game-farm from pure wild Mallards in-hand during banding operations. We hypothesize that morphological traits can be used to assign ancestry to individuals in the field during tagging and banding without the constant need of molecular assessment. Our research will rely on morphological cataloging and the analysis of feather patterns using artificial computer intelligence technology to test our ability to differentiate among generational hybrids of Mallards during pre-season banding and harvest surveys. We will collect 13 morphological measurements and a series of photos, each highlighting a different morphological attribute. Preliminary results suggest that significant relationships exist between specific morphological attributes and genetic assignment. Field identification of wild, game-farm, and generational hybrids would present a powerful tool for Mallard population research and conservation efforts.

Understanding Effects of Domestic and Wild Mallard Introgressive Hybridization on Spring Migratory Behavior

Presented by: Ryan Askren (raskren@5-oaks.com)

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N.M. Masto, Tennessee Tech University
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The annual releases of captive-reared mallards (Anas platyrhynchos) has been widespread in the Atlantic Flyway for over a century. However, recent studies suggest that the prevalence of feral game-farm and game-farm × wild mallard hybrids (hereafter, hybrids) are not geographically isolated to the Atlantic Flyway. Connectivity between Atlantic and Mississippi Flyway mallard populations has been identified and suggests potential for game-farm genetic variation to move westward. Hybrid mallards were bred for recreational purposes and therefore would be expected to vary in morphological and behavioral phenotypes. Here, we coupled genetic and GPS telemetry data for 332 wild-caught mallards captured in Arkansas and Tennessee to test for differences in migratory behaviors among individuals of varying game-farm mallard ancestry (range = 0.0–0.24). Preliminary results suggest that migratory step length was not strongly influenced by game farm genetics or interactions thereof ($r^2 = 0.06$); however, game-farm hybrids were more likely to select stopovers or breeding sites closer to urban areas ($r^2 = 0.37$) depending on latitude ($r^2 = 0.73$). We suggest early hybrid mallards are likely to stop more frequently and therefore establish residency in more southerly latitudes near metropolitan areas than wild mallards. While previous studies have established the extent of gene flow between game-farm and wild mallards, our study is the first to test for differences in migratory phenotypes as a function of game farm ancestry. This study suggests a relatively low occurrence of hybrid mallards in the Mississippi Flyway, likely related to the strong connectivity between ancestral breeding grounds in the Prairie Pothole Region. We suggest future studies couple molecular and GPS-tracking technologies to investigate mechanisms and potential maladaptive phenotypes of game-farm hybridization.

Atlantic Flyway Mallards: Deriving Migration Metrics from GPS/GSM Data

Presented by: Daria Sparks (dspar2@brockport.edu)

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J. Stiller, New York State Department of Environmental Conservation
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N. Huck, Pennsylvania Game Commission
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Mallard (Anas platyrhynchos) breeding abundance surveys show differential rates of population decline between a stable population in Eastern Canada and Maine compared to an average decline of 1.6% annually in the Northeast United States since 1998. We initiated a multi-year (2022-2026) study to capture female mallards then affix Ornitela GPS/GSM communication transmitters to better understand demographic rates, migration chronology, and habitat use. We will compare mallards that breed in the Eastern Survey Area and those that breed in the Atlantic Flyway Breeding Waterfowl Survey Area. In two years, 645 transmitters have been deployed in January - March of each year from New Brunswick to South Carolina. Of 336 mallards marked in 2022, 232 survived long enough to be considered in an analysis of spring migration movements. We used minimum convex polygons to identify 156 individuals (67.2%) who made what we termed long-distance migrations. The mean migratory distance for these individuals was 764 km. We fit hidden Markov movement models to long distance migratory tracks consisting of hourly locations to ascribe departure date from wintering grounds, Euclidean distance migrated, length of time spent migrating and arrival date on the breeding ground. We will expand our approach to include all available data for spring and fall migration and short-distance migrants. These preliminary analyses will inform project objectives, including building a comprehensive picture of the full annual cycle for mallards in eastern North America. Understanding when mallards are settling in survey strata of the Northeast can inform survey timing for states within the flyway to ensure the population is being accurately sampled and recounting is minimized.

Body Mass Dynamics in Wintering Mallards (Anas Platyrhynchos) in the Lower Mississippi Alluvial Valley

Presented by: John Veon (jtveon@ucdavis.edu)

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Recent research from Europe and the western United States suggests that mallards (Anas Platyrhynchos) have increased in body mass from the late 1960s to early 2000s. It is hypothesized that mass increases are due to a more benign winter climate, increased food availability, shortening of migration distances, or hybridization with pen-reared mallards that were released into the wild. This phenomenon has yet to be studied within the Lower Mississippi Alluvial Valley (LMAV). Because most waterfowl management plans in the LMAV are based on energy requirements for mallards and body mass can be directly tied to energy acquisition in waterfowl, it is important to further understand how mallard body mass may have changed over time. We analyzed body mass dynamics in mallards sampled throughout the LMAV of Arkansas and Mississippi from 1979-2021 to establish whether similar increases in mass have occurred. During the duck hunting seasons, we measured harvested mallards from public hunting areas, hunting clubs, and duck-plucking businesses. For each bird, we determined sex, age, and recorded body mass measurements. We used linear mixed-effects models to explore mallard body mass trends within seasons and across time, as well as in response to meteorological variables and age and sex groups. Our results determined that mallard body mass has increased by approximately 6% among all age-sex groups over the last four decades, while body mass decreased within years over the course of the hunting season. Mallard body mass also increased after periods of increased rainfall or river flooding, likely due to increased food availability. Our research demonstrates that changes in mallard body mass are widespread and that within-season precipitation and flooding most likely influence much of the observed annual variation. Future research should investigate other potential mechanisms contributing to these trends such as introgression of game farm mallard DNA and climate change.

duckDNA: Engaging Hunters in the Study of Waterfowl Genetics

Presented by: Ashley Tunstall (atunstall@ducks.org)

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Contemporary research in conservation genetics is playing an increasingly important role in the management of wildlife populations. New discoveries are advancing our understanding of species phylogenetic relationships, unseen population structure, species divergence processes, and consequences of human-induced secondary contact (i.e., introgressive hybridization). Recent research revealed that over a century of game-farm mallard releases has caused the development of a hybrid swarm in the Atlantic Flyway, resulting from persistent hybridization between wild and game-farm mallards. Preliminary results from ongoing studies have identified differences in behavioral, morphological, and ecological traits between game-farm hybrids and pure wild mallards, some of which may impact annual productivity, movement, and distribution across their range. Given recent discoveries of the westward expansion of game-farm hybrids across North America, researchers are seeking to expand the temporal and spatial scale of genetic sampling to investigate and monitor this issue. To help address this need, Ducks Unlimited, Inc. and the University of Texas at El Paso initiated a project to engage waterfowl hunters in providing tissue samples from harvested ducks across the U.S. The goal of this project, operating under the name duckDNA, is to create the world's largest database of waterfowl genomes and enable expanded studies of genetic processes in waterfowl and their implications for population management. During the 2023–24 hunting season, we will select up to 300 waterfowl hunters to submit tissue samples from up to 1,500 ducks, with an emphasis on submissions from mallards, American black ducks, mottled ducks, Mexican ducks, and all hybrids. This presentation will provide an overview of the duckDNA project and summarize findings from the 2023–24 season, including hunter response, community engagement, and preliminary data.

Minding Our Mallards? Who's Looking After the Mallards for the Next Generation(s)

Presented by: Michael Schummer (mlschumm@esf.edu)

M. Schummer, SUNY College of Environmental Science and Forestry
P. Lavretsky, University of Texas at El Paso

Mallards are among the most ubiquitous waterfowl on the planet. They have a rich evolutionary history which also includes their interactions with humans. World-wide, mallards have wild populations that are among the most harvested of waterfowl in many northern hemisphere locales. Mallards have a rich history of domestication for food and as a supplement to wild populations when released as game-farm mallards. Despite being among the most studied game-species in North America and beyond, we provide an abundance of new information on mallards in this session. Specifically, we highlight the substantial changes to the genetic integrity of the wild mallard population in North America that resulted from constant reinforcement of game-farm mallard genes through annual releases; it takes but “one migration per generation” to sustain genes in a population. We note throughout this session that game-farm mallards are subject to environments that are strongly different from the selective pressures in the wild. In Europe, the practice of releasing mallards has changed the morphology of the wild mallard population and we see evidence of similar changes spreading throughout North America. In France alone, 1.3 million mallards are released annually but their wintering population of wild mallards is only estimated as 270,000. The consequences of introgression of artificially selected traits from game-farm into the wild mallard population are predictable, but the scientific process requires a burden of proof. So, who is minding our mallards in North America? We see sustaining wild mallards in North America of utmost importance because of the ecological, environmental, economic, and cultural roles they play. In this session ending talk, we will summarize future research needs as compiled from the session speakers. Game-farm mallard genes moving west across North America corresponded with declines in mallard populations. What if the mid-continent mallard population collapsed? Who is minding our mallards?

The Mallard in the Anthropocene

Presented by: Pär Söderquist (par.soderquist@hkr.se)

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J. Champagnon, Tour du Valat
J. Elmberg, Kristianstad University
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R. Clark, Pacific Wildlife Research Centre, Environment and Climate Change Canada

In the Anthropocene human activities are a dominant force affecting wildlife, natural habitats, and climate worldwide. Over time, increasing incidences of wildlife-human interactions may have positive outcomes for some generalist species, but studies continue to uncover that most predictably these generalist wild species also suffer from such interactions. In particular, the line between domestic and wild continues to blur as gene flow between these groups intensifies, and some species become increasingly dependent upon human activities. We explore the meaning of wildness, focusing on the mallard, currently the most abundant duck species in the world. The mallard has been connected to humans for tens of thousands of years, so that even when not farmed it exemplifies a true anthropophilic species. Considered a typical generalist species with the capacity to adapt to rapidly changing environments, evidence gathered from several disciplines suggests that some management efforts have resulted in the deterioration of the mallard's prolific nature and apparent success in terms of current population size and wide distribution could mask a genetic collapse. Highlighting warning signs from the mallard system, we discuss how active management of habitats and duck populations runs the risk of compromising species' wildness, and we suggest precautionary countermeasures in the context of species management and conservation.

True Metabolizable Energy of Waterfowl in Illinois

Presented by: Therin Bradshaw (therinmb@illinois.edu)

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M.R. Williams, Western Illinois University
H.M. Hagy, U.S. Fish and Wildlife Service
J.D. Lancaster, Gulf Coast Joint Venture, Ducks Unlimited, Inc.
A.D. Gilbert, Forbes Biological Station - Illinois Natural History Survey
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A.M.V. Fournier, Forbes Biological Station - Illinois Natural History Survey

True metabolizable energy (TME) assays were developed to refine poultry diets but have been adapted to determine the available metabolizable energy within natural wetland foods for waterfowl. TME values of wetland food resources are needed before generating bioenergetic models to calculate the impacts management has on the energetic carrying capacity of wetlands. Prior TME research has focused on the food items commonly found in waterfowl diets and mostly focused on a single species of waterfowl, leaving an information gap within multiple waterfowl species and moist-soil seeds. In this project, we determined TME values of moist-soil seeds considered beneficial (i.e., Cyperus erythrorhizos, Cyperus iria, Leptochloa panicoides, Panicum rigidulum, and Persicaria lapathifolium) and seeds considered unfavorable (i.e., Persicaria hydropiperoides, Sesbania herbacea, and Sida spinosa) within three species of wild-caught waterfowl (i.e., mallard [Anas platyrhynchos], northern pintail [A. acuta], and green-winged teal [A. crecca]). From December to February 2019-2022, we completed three fasting trails and 27 feeding trials across three duck species and eight seed species during the non-breeding period. Trails began with a fasting period, with the length of time determined by examining data collected during fasting trails (24-hourds for A. platyrhynchos and A. acuta, 12-hours for A. crecca). Following the fasting period, we fed individuals a seed mass equivalent to 1% of an individual's body mass. Once fed, the individuals were held for an additional fasting period to allow the collection of excreta associated with the ingested seeds. Excreta was dried and remaining energy (Kcal/g) was quantified using a calorimeter. Our results will be used to support conservation planning models to refine waterfowl objectives stepped down from the North American Waterfowl Management Plan to better inform waterfowl conservation planners and wetland managers throughout the Mississippi Flyway of the United States.

Bioenergetic Capacities of Private Lands Enrolled in the Texas Prairie Wetlands Project

Presented by: Macayla Greider (mgreider@ducks.org)

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K. Hartke, Ducks Unlimited, Inc.
J. Lancaster, Gulf Coast Joint Venture, Ducks Unlimited, Inc.
B. Wilson, USFWS Gulf Coast Joint Venture

Since 1991, the Texas Prairie Wetlands Project (TPWP) has provided cost share and technical assistance to private landowners along the Texas Gulf of Mexico coast to increase availability of seasonal shallow wetlands. The underlying premise of the TPWP is to contribute to Gulf Coast Joint Venture (GCJV) habitat objectives for waterfowl, ensuring wintering and migration habitat for waterfowl that maintain sufficient body condition and overwinter survival to enable successful spring migration. Throughout the last 30 years, the TPWP has delivered ~90,000 acres on 1,706 individually managed units. According to GCJV habitat assessment data, on average ~44,600 (52%) of enrolled and expired TPWP acres are flooded during one or more of the early (Aug 16th-Oct 31st), middle (Nov 1st – Jan 15th), or late (Jan 16th- March 31st) monitoring periods annually. Seasonal wetlands enhanced through the program provide an estimated 27 million Duck Energy Days, a measure of foraging capacity estimated to energetically support 270,000 ducks and geese for 100 days. Wetlands restored or enhanced through the program also provide 3.8 billion cubic feet of flood storage potential, which can help mitigate damage from hurricanes and tropical storm events. Providing wintering waterfowl habitat and other ecosystem services through programs like the TPWP is of increasing importance as natural wetlands degrade in quality and land uses along the Texas coast shift to urban development.

Factors Affecting Use and Depletion of Unharvested Flooded Corn by Wintering Waterfowl

Presented by: Cory Highway (chighway42@tntech.edu)

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A.G. Blake-Bradshaw, Tennessee Tech University
A.C. Keever, Tennessee Tech University
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D.L. Combs, Tennessee Tech University
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Loss of historic wetlands throughout the Mississippi Alluvial Valley has changed foraging strategies of migrating and wintering dabbling ducks. Natural food sources are increasingly scarce, and supplemental planting and flooding of agricultural crops for waterfowl is becoming more popular for private and public land managers. Unharvested flooded corn is a widespread waterfowl management practice in the Mississippi Alluvial Valley (MAV) and elsewhere. Use and subsequent depletion of unharvested flooded corn fields may be impacted by proximate anthropogenic disturbance and predation risk, which in turn, shifts the bioenergetic landscape for waterfowl. We surveyed 145 private-public unharvested flooded corn fields to estimate initial biomass in October 2019 and 2020, prior to any waterfowl use, in western Tennessee, USA. To quantify depletion, we randomly selected and repeatedly surveyed 60 of the 145 corn fields biweekly until March 2020 and 2021. We measured field-level factors that we predicted may affect depletion of unharvested flooded corn among land ownership entities. Private properties provided greatest corn biomass (7,134 ± 448 kg/ha), followed by public properties (5,272 ± 320 kg/ha), and lastly waterfowl sanctuaries (3,995 ± 371 kg/ha). Likewise, corn depletion was fastest on sanctuaries, followed by public, then private fields. Additionally, fields with water surface closer to corn ears were depleted faster. Importantly, sanctuary fields were completely depleted by mid-February, whereas the majority of public and private fields had corn remaining by March 15th. Furthermore, we estimated 49 ha of private corn fields surveyed in 2020 contributed nearly seven times more duck energy days than was allocated by the Lower MAV Joint Venture. Conservation planning will benefit from increasingly accurate assessments of private land energy contributions which may allow public-land managers to maximize wetland diversity to benefit a wide-range of species without as strong an emphasis on waterfowl energetic foraging habitats.

Estimating Energetic Density of Winter Foraging Habitat in South Atlantic Coastal Wetlands

Presented by: Stephen Clements (sc2849@msstate.edu)

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The South Atlantic region of the U.S. contains diverse wetlands including tidal managed and non-managed marshes, inland bottomland swamps, and impounded agricultural crops. These systems are all used by waterfowl, however hydrologically managed tidal impoundments (MTIs) along the coast are among the most important aquatic resources for waterfowl and other waterbirds in the Atlantic Flyway. Many of the MTIs in the region are managed for naturally occurring submersed aquatic vegetation (SAV) and associated seeds, tubers, and aquatic invertebrates. However, these systems face threats from sea-level rise and tropical storm severity and frequency. Concomitantly, region-specific estimates of waterfowl forage production in MTIs and other managed wetlands are lacking. Therefore, we devised a study to estimate forage biomass and subsequently, energetic density, of three managed wetland types in coastal North Carolina and South Carolina. During late-summer and early-fall of each field season, we sampled MTIs, moist-soil wetlands, and impounded corn fields using a multi-stage sampling design to obtain forage production estimates prior to arriving migratory ducks. In the MTIs, we collected SAV samples and soil cores to estimate the biomass of vegetation, seeds, and macroinvertebrates. For moist-soil and flooded corn impoundment sampling, we used field proven rapid assessment techniques. During the 2021 and 2022 field seasons, we collected 366 SAV samples and 847 soil cores from 44 MTIs and conducted 45 and 39 moist-soil and corn assessments, respectively. Preliminary results indicate that the forage biomass production was 619, 254, and 4,092 kg/ha in SAV, moist-soil, and flooded corn wetlands, respectively. Although corn impoundments have a greater biomass, all of the sampled wetland types function collectively to meet the nutritional requirements of waterfowl. Thus, understanding forage production in managed coastal wetlands will benefit mitigation efforts as the integrity of coastal wetlands is damaged from sea-level rise, tropical storms, or other challenges.

Bioenergetics and Annual Movements of Green-Winged Teal (Anas crecca) in the Atlantic Flyway

Presented by: Cole Tiemann (chtiema@udel.edu)

C. Tiemann, University of Delaware
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Green-winged Teal (Anas crecca) have not been extensively studied in the Atlantic Flyway, presumably because of their stable population status across their range. There is also a lack of telemetry studies due to their small size. However, recent technological advances have allowed for 10-gram GPS/GSM units to collect high-frequency GPS data on teal across their life cycle. This project has attached 74 transmitters to teal in North Carolina in 2021-2023 (2 study sites including freshwater and coastal systems) and collected GPS points across the winter, spring migration, summer nesting, molting, and fall migration, all of which has not been done before in the Atlantic Flyway. We compared home range size and habitat selection across our capture sites, as well as day/night use and other important metrics across their migratory and breeding range. This data helps build on the foundation of over 100 years of band-recovery data, but also identifies important sites and habitat types that teal use across their range at a fine scale in order to help guide public and private habitat management for teal. In addition, this project aims to create a bioenergetics model for teal in the Coastal Plain of North and South Carolina. Teal foods were identified and 123 core samples and 312 sweep-net samples were collected across 7 distinct habitat types in order to identify food availability on the landscape for teal. To identify energy expenditure, we conducted 429 instantaneous scan samples and used 17,358 accelerometry bursts from marked teal to identify behavioral proportions, combined with real-time weather data to account for thermoregulation. Lastly, we used the National Wetlands Inventory data layer to calculate available habitat for teal, and extrapolated energy at a landscape level. Using these extrapolated values combined with energy expenditure, we identified duck-energy days in our study area over the wintering period.

Empirical Evidence Mike Anderson Is 1,576,800 Times Smarter than Mike Eichholz

Presented by: Mike Eichholz (eichholz@siu.edu)

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J. Simpson, Winous Point Marsh Conservancy
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The Upper Mississippi / Great Lakes Joint Venture (JV) uses a bioenergetics modeling approach to convert non-breeding waterfowl population objectives to habitat restoration and retention objectives. After 15 years and considerable financial resources expended refining parameter estimates, the JV's latest model estimate indicates an additional 163,114 ha of wetlands are needed to meet non-breeding waterfowl energy needs when populations are at NAWMP goals. Since developing this conservation objective in 2017, new research suggests the JV may have dramatically overestimated resource availability and underestimated resource demand. For example, a recent study indicates only about 50% of wetlands in Illinois are inundated during the period of spring duck migration, reducing wetland-based food availability from our estimates by 50%. Additionally, a recent study conducted by the Iowa DNR indicates only about half of breeding ducks available for counting are detected during traditional BPOP aerial surveys. Combined, these results suggest an additional 652,456 ha of wetlands may be needed in the JV region to support actual population abundances. Based on this revised model estimate, we would expect limited food to adversely affect nutrient dynamics of ducks during spring migration in the JV region. Results of previous studies of ducks, however, indicate at least some species are in fact gaining fat and protein reserves during spring-migration stopovers within the JV landscape, suggesting our current bioenergetics planning approach is not functioning as desired. Moreover, JV priorities are transitioning to better reflect social considerations and themes presented in recent revisions of the NAWMP. With tis presentation, we demonstrate shortcomings of our bioenergetics approach and provide an example of how our JV is pursuing a modified habitat modeling system that incorporates the ecological and social services provided by wetlands into objective setting and spatial prioritization, thus creating a more holistic and sustainable planning process.

An Alternative for Evaluating the Energetic Landscape for Mallards Anas Platyrhynchos in the Mississippi Alluvial Valley, USA

Presented by: Duncan Fraser (brian.davis@msstate.edu)

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D. Adjaye, Mississippi State University
J. Dentinger, Mississippi State University
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G. Ripa, Mississippi State University
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C. Sklarczyk, Mississippi State University
B. Thornton, Mississippi State University
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R. Kaminski, Clemson University (Retired and Emeritus)
D. Fraser, Mississippi State University
B. Davis, Mississippi State University

Habitat conservation planning for wintering waterfowl in North America aims to support energetic carrying capacity of regional populations using a landscape-population perspective. However, because spatial and temporal configuration of resources can influence individual animal space use, there may be benefits to considering the potential availability of energy from the individual's perspective in conservation planning. This possibility was evaluated for Mallards Anas platyrhynchos wintering in the Mississippi Alluvial Valley using: (1) published energetic values for different landcover types (quantified as duck energy days; DEDs/ha), (2) maps of landcover and water availability, and (3) winter home range estimates created using location data from 128 radiomarked birds. Per current methods used in regional assessments, landcover types were first transformed into their corresponding DED values, and then the amount of energy considered possibly accessible to Mallards within their home ranges was restricted using water availability and DED decay rates. Relatively energy-rich landcover types, such as moist-soil wetlands and croplands, were less likely to be accessible given water coverage. Moreover, a large proportion of Mallard locations were in areas that provided no apparent energetic value. Most (> 90%), but not all, home ranges surpassed minimum winter energetic needs (i.e., 123 DEDs). We suggest that waterfowl habitat conservation planning should consider our alternative individual bird, home-range approach for DED assessments of focal waterfowl species and use those assessments to begin examining potential gaps in landscape water coverage, provision of habitat complexes, and resource patch adjacency at the home range scale.

Re-Evaluating Waterfowl Carrying Capacity Using Diet, Body Condition, and Foraging Behavior

Presented by: Jacqueline Satter (jmsatter@ucdavis.edu)

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The Winter Food Limitation Hypothesis has provided an important conceptual framework for the North American Waterfowl Management Plan since 1986 and has been a primary tenet of winter habitat management for the past 35 years. This fundamental ecological principle has rarely been deeply challenged for waterfowl, and should be conceptually revisited as management techniques change, as landscapes change, and as the environment is increasingly affected by climate change. We attempted to deconstruct the mechanisms underlying food limitation by studying the variation in diets, body condition, and foraging habits of seven species of dabbling ducks that co-occur in California over winter from Oct-Dec. Specifically, we examined patterns between and amongst species, between and amongst sexes, correlations between diet and body condition, and seasonal trends of each of these categories. We are also conducting cafeteria-style foraging experiments using captive waterfowl to determine how much variation can be attributed to classic niche compartmentalization factors such as body size, lamellar spacing, food size, and water depth. By better understanding nutritional niche stochasticity of different species and sexes, intra and interspecific interactions between these groups, and variance attributed to alternative niche differentiation, we will be better equipped to adapt future management efforts and the carrying capacity models that inform them.

Foraging Interactions of Sympatric Waterfowl on the Yukon-Kuskokwim Delta in Alaska

Presented by: Jacob Tepsa (jteps334@uwsp.edu)

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Some populations of black brant (Branta bernicla nigricans) in Alaska are declining because of reduced productivity and juvenile survival. Sympatric species including emperor geese (Anser canagicus) and cackling geese (Branta hutchinsii minima) have experienced similar population declines in the mid to late 1900's but have since recovered. Grazing lawns made up of short graminoid swards serve as a preferred and shared source of forage for multiple species during brood rearing. Consequently, grazing lawn conditions and foraging behaviors may impact gosling growth rates and survival. Little is known about the role of intra- and inter-specific foraging behaviors in relation to whether species facilitate foraging conditions or compete for resources. We deployed 25 trail cameras among 5 traditional brood-rearing areas on the Yukon-Kuskokwim Delta in Alaska during the summer of 2023. Cameras were placed on grazing lawns of varying size to monitor interactions between sympatric species in comparison to lawn conditions. Videos and photos were then categorized according to the density of each species along with the displayed behavior of each adult goose and gosling. Additionally, point-sampling of vegetation was recorded near the camera-trap locations. Our study aims to understand the influence of interspecific foraging behaviors on food resources and demographic consequences for at-risk species that are also an important subsistence resource on the Yukon-Kuskokwim Delta.

Evaluating the Diets of Ducks Using South Atlantic Coastal Wetlands

Presented by: Stephen Clements (sc2849@msstate.edu)

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Diets of North American ducks are quite diverse and correctly identifying and including various prey items in analyses is fundamental to estimating energetic carrying capacity. Waterfowl food habits studies in the South Atlantic region were conducted extensively during the 1960s and 1970s, mostly reporting on food contents in gizzards of various species. Methodologies for collecting food habits data have substantially evolved to avoid potential biases in food habits estimation. The South Atlantic region remains important to numerous waterfowl species; thus, contemporary region-specific food habits data is needed to improve estimates of energetic carrying capacity. A powerful contemporary technology evaluates DNA to determine diet composition from birds' feces, which does not require lethal collection of the target species by researchers. This technique is especially useful for the South Atlantic region where many public and private waterfowl hunting areas prioritize minimizing waterfowl disturbance, including traditional collections that involve shooting actively foraging birds. To meet this information need, we designed a study to: 1) compare duck diets revealed through morphological (i.e., traditional) and molecular (i.e., DNA) diet identification methodologies and 2) compare diets among those duck species collected. We have completed two of three field seasons to date and have collected 702 feces samples from 9 species of hunter-harvested ducks and harvested 85 actively foraging ducks. Preliminary results indicate that, collectively, diets of ducks foraging in managed tidal impoundments primarily consists of seeds (53%), especially those from submersed aquatic vegetation that are purposefully promoted by wetland managers. However, diets varied by species, where, for example, gadwall (Mareca strepera) consumed 56% vegetation and blue-winged teal (Spatula discors) diets were 62% invertebrates. Further analysis will be conducted as DNA sequencing continues at this time.

Foraging and Diving Locations of Wintering Lesser Scaup in the Chesapeake Bay

Presented by: Hannah Schley (hschley@udel.edu)

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Over the past two decades, lesser scaup (Aythya affinis) populations have been declining, bringing focus to breeding ground habitats and reproductive requirements. However, the winter food limitation hypothesis also hypothesizes the availability of food for energy is the primary factor limiting wintering waterfowl populations. Therefore, it is important to understand scaup foraging ecology in significant wintering areas such as the Chesapeake Bay as well as local distributions of lesser scaup. Past research on scaup foraging ecology in this region has been restricted to diet analyses from hunter-harvested birds; however, continuous landscape changes around the Chesapeake Bay may have altered the type, quantity, and distribution of food resources available thus impacting their habitat use and populations. Using GPS locations from 29 GPS-GSM marked scaup during the 2021-2022 and 2022-2023 wintering seasons, we first identified preferred habitat within the Chesapeake Bay. Second, we used behavior observations and remote transmitter tri-axial accelerometer (ACC) data to distinguish crucial diving (i.e. feeding) locations. Last, we used landscape-level and environmental variables to model key characteristics of feeding areas to provide insight into scaup wintering needs and resources

Linear Feature Effects on Settling and Productivity of Ducks in the Western Boreal Forest

Presented by: Matt Dyson (matt.e.dyson@gmail.com)

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The creation of linear features, including roads, pipelines, and seismic lines, are necessary for oil and gas extraction and has increased greatly throughout the boreal forest and will likely continue to increase for decades. The effect of linear features on breeding ducks is largely unknown, leaving conservationists, wildlife managers, and industry leaders with little knowledge to guide policy recommendations. We evaluated relationships between linear features and breeding ducks in the Western Boreal Forest using aerial survey data from 2013 to 2016. We explored how spatial scale, linear feature density, riparian edge density, and proximity to wetlands related to pair abundance and productivity across nine species and three nesting guilds. Using dependent double observer data, we built hierarchical models to estimate detection and availability corrected abundance. Detection for pairs and broods was high (0.84 – 0.94) but availability was relatively low (0.32 – 0.61). At the survey block scale (2.5 km x 2.5 km), pair abundance and productivity increased with seismic line density across guilds and ground-nester productivity increased with road density, with diminishing effect as riparian edge density increased. At the wetland scale, ground nesting pairs increased with increasing pipeline and seismic line density, but productivity declined closer to seismic lines and pipelines. In addition, we will highlight species-specific effects that drive guild responses. We interpret differences in scale-specific responses to suggest that at current levels of development, ducks can mitigate negative effects observed at the wetland scale. Managers should continue to monitor how ducks respond to landscape change in the boreal forest, including cumulative effects, and ensure implementation of sustainable land use practices that provide refuge habitat.

Breeding Waterfowl Habitat Selection in the Taiga and Its Contribution to Future Survey Efforts

Presented by: Eric Reed (eric.reed@ec.gc.ca)

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The Taiga Shield and Taiga Plains ecozones cover a significant proportion of the Canadian north and support a large and diverse assemblage of waterfowl populations during the breeding season. However, due to the remoteness of much of these ecozones, limited information is available regarding distribution, abundance, or trends. Some waterfowl, such as scoters (Melanitta sp.) and scaup (Aythya sp.), breed predominantly within these ecozones and the lack of information on populations severely limits our capacity to manage their harvest in a sustainable way. Habitat selection models allow the identification of important environmental variables for breeding waterfowl and provide a basis for predicting distribution and abundance over large spatial scales. From 2016-2019, we conducted experimental surveys timed to coincide with scoter and scaup breeding phenology in the Canadian portion of the Taiga ecozones. Survey areas were spread across a wide east-west gradient, from northern Québec to northwestern Northwest Territories. All species of waterfowl and waterbirds were recorded during surveys and locations were georeferenced. We extracted hydrological, elevation, bioclimatic, snow cover and vegetation data from national and continental databases and modeled their relationship with observation data using Generalized Additive Models (GAM) for all common species. The best supported model for each species was then used to predict relative abundance over the Taiga ecozones. Habitat selection models and associated predictions will provide a better understanding of the area's importance to breeding waterfowl, especially for those species whose breeding ranges are primarily located in the Taiga. This information can also provide the foundation for future surveys, targeting species that mostly fall outside of the WBPHS. It can also provide a framework for adaptive learning where new survey data from the area can be used to validate and/or update existing habitat selection models.

Polar Bear Predation of Seaduck Nests: Causes, Consequences and Projections for the Future

Presented by: Grant Gilchrist (grant.gilchrist@ec.gc.ca)

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The loss of Arctic sea ice is causing polar bears to spend more time in terrestrial environments, and is limiting their ability to hunt marine mammals. As a result, polar bears are consuming more bird eggs, and are causing widespread reproductive failure in colonial nesting birds. We have been using aerial videography, landscape level surveys, and long-term data sets to study interactions between polar bears and nesting common eider seaducks in the Eastern Canadian Arctic. Our research demonstrates that polar bear predation of seaduck nests has increased, and is predicted to increase in the future, which may have widespread consequences for polar bear and seaduck populations.

Spatial and Temporal Genetic Structuring in Colonially Breeding Red-Breasted Mergansers (Mergus serrator)

Presented by: Emily Burt (emily.burt2@mail.mcgill.ca)

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Natal philopatry and nest site fidelity lead to spatial and temporal genetic structuring in a population, and therefore result in kin grouping. Kin selection can also promote the grouping of nests and synchronous nest initiation amongst genetic relatives, and particularly under conditions in which selection favors interactions among genetic relatives, such as conspecific brood parasitism. We aim to resolve both the site-level and fine-scale spatial genetic structuring in a colonial population of red-breasted mergansers (Mergus serrator) that exhibit high rates of conspecific brood parasitism on two barrier islands in New Brunswick, Canada. Using genetic markers to genotype individuals and calculate pairwise kinship coefficients across three breeding seasons, we are assessing the genetic relationships between pairs of hens at two spatial scales; i) island-level and ii) fine-scale distance intervals of 50m, as well as at a iii) temporal scale using nest initiation dates. Results from the first breeding season did not find support for genetic structuring at either spatial scale, and nest initiation dates were not found to be related to kinship. However, nesting began earlier on one island and hens nesting in proximity on this island were relatively synchronous in nest initiation chronology. Thus, our preliminary results suggest that island-level landscape features rather than kin selection influence nesting decisions in this population of red-breasted mergansers.

Forecasting Waterfowl Distribution and Abundance in the Canadian Western Boreal in Face of Cumulative Impacts of Climate Change

Presented by: Amelia Cox (amelia.cox@ec.gc.ca)

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The western boreal forest is a crucial breeding ground for North American boreal waterfowl, and is thought to serve as a key refuge for some duck species during drought periods in the Prairies. Climatic changes in the western boreal are expected to have important cascading effects through increased wildfire, drought and associated changes on forest composition and structure. Here, we developed species abundance models using generalized additive models for 17 waterfowl species from fixed-wing transect data from the Waterfowl Breeding Population and Habitat survey (2000-2019) to identify how 14 habitat covariates influenced waterfowl occurrence and abundance. We also selected habitat covariates that were forecasted by other landscape simulation modules implemented in the SpaDES ecological prediction platform, which enabled us to forecast changes in abundance and distribution under different climate change scenarios, accounting for cumulative impacts on waterfowl species. Habitat associations and spatial abundance patterns varied across species, but models performed well and explained on average 40.3% of the deviance (range 20.7-63.1%). Our models forecast declines in boreal specialists (scoters, Ring-necked Duck, mergansers, goldeneye, and Bufflehead) in large areas of their range by 2040, 2070, and 2100. Most of these declines are expected at the southern edge of the western boreal forest and abundance is forecast to remain stable or increase at the northern edge. Conservation planning for the western boreal forest will need to address cumulative impacts of climate change to offset the loss of southern boreal habitat, especially for habitat specialists, if we want to maintain those populations above their NAWMP targets.

Long-Term Changes in Nest Sites of Canvasback in a Dramatically Altered Environment

Presented by: Michael Johnson (mk.johnson@colostate.edu)

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Habitat selection is an important evolutionary process where an individual makes decisions regarding the habitat it chooses to occupy at various scales of the environment to enhance fitness. Canvasbacks are the primary host to parasitic redheads where these species' breeding ranges overlap and deciding where to juxtapose nest sites that reduce encounters with predators and guard against discovery by parasitic redhead females may induce trade-offs, especially in landscapes that have been heavily altered by agriculture. Our main objective was to classify elements of the landscape that may influence both the survival probability of nests as well as their exposure to effects associated with interspecific parasitism. We used canvasback nest-site locations from two studies near Minnedosa, Manitoba (1983-1990 and 2015-2021) that bookend a period of dramatic population growth in redheads and subsequently, an increase in interspecific brood parasitism, amidst dramatic changes in the surrounding landscape. We hypothesized that minor changes in nesting locations suggest selection associated with long-term predation pressures, whereas more prominent changes would occur in response to increased parasitic pressure or anthropogenic alterations to the landscape. Overall, canvasback nest survival has remained remarkably stable over the two study periods highlighting local adaptability against a diversifying predator community.

Diving at High Altitude: O2 Transport and Utilization in Andean Ruddy Duck and Torrent Duck

Presented by: Kevin McCracken (kevin.g.mccracken@gmail.com)

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Hypoxia and cold temperatures create unique physiological challenges for high-altitude organisms that can vary depending on lifestyle. While nearly all studies of air-breathing animals at high altitude are from terrestrial species, species that breath-hold dive underwater at high altitude encounter a very different set of selective pressures influencing their phenotype. The goal of this publication is to highlight the changes in O2 transport and utilization in high-altitude divers relative to diving birds at sea level, and the extent to which these changes are qualitatively distinct from phenotypic changes in non-diving species at high altitude. For example, while high capacities for sustained O2 transport may be required for sustained flight and thermogenesis (particularly in small endotherms), high-altitude breath-hold diving is a form of intense exercise uniquely defined by transient and sometimes severe O2 depletion (hypoxemia) and CO2 accumulation (hypercapnia), interspersed by recovery between dives when O2 stores must be rapidly replenished despite the hypoxic environment at high altitude. Given this, diving behavior may preclude or constrain the physiology of divers, such that high-altitude divers are predicted to exhibit qualitatively distinct phenotypic changes compared to non-divers, as each likely experience unique signals for phenotypic plasticity and selective pressures driving their evolution. Here, we reanalyze and synthesize new and recent findings describing O2 transport for two high-altitude breath-hold divers in the Andes of South America, the ruddy duck (Oxyura jamaicensis) and the torrent duck (Merganetta armata). Analysis across the O2-transport cascade including (1) ventilation, (2) pulmonary O2 diffusion, (3) circulatory O2 delivery, (4) tissue O2

diffusion, and (5) tissue O2 utilization reveals that different routes to functional adaptation have emerged between diving and non-diving birds in the high Andes.

Physiological Correlates of Dive Time in 16 Species of North American Diving Ducks

Presented by: Elizabeth Schell (elizabeth.r.schell@gmail.com)

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Diving animals must sustain high rates of aerobic respiration in the working muscle on a single breath while foraging underwater, creating a potential mismatch in oxygen (O2) supply and demand. Studies have shown that diving animals correct for this mismatch through increases in whole-body O2 storage capacity and changes in locomotory muscle structure and metabolism. Here, we quantified blood and muscle O2 stores, locomotory muscle (gastrocnemius, primary diving muscle) ultrastructure characteristics, and changes in metabolic pathways related to oxidative and substrate-level phosphorylation to explore changes associated with diving in 16 species of diving (sea ducks, pochards) and non-diving ducks (dabblers). Across all three levels of O2 transport studied, we found distinct differences between the sea ducks and dabblers, with the pochards generally showing an intermediate phenotype. Compared to the dabblers, sea ducks had significantly higher hemoglobin and myoglobin concentrations, preferential proliferation of mitochondria close to the cell membrane and capillary blood supply, and increased activities of citrate synthase and cytochrome c oxidase, both key mitochondrial enzymes for aerobic respiration. Further analyses showed that muscle myoglobin, citrate synthase activity, and average muscle mitochondrial density were the most highly correlated with mean dive times in these species. These data suggest that diving ducks increase total onboard O2 stores in the blood and muscle, and that the gastrocnemius is specialized for sustaining high rates of aerobic metabolism. These observed changes would work to maximize O2 extraction from blood and muscle stores as O2 tension decreases during later stages of a dive, as well as augmenting aerobic ATP generation to sustain intense underwater exercise while foraging.

Assessing Thiamine Deficiency in Diving and Sea Ducks in the Lake Ontario Watershed

Presented by: Jacob Straub (jstraub@brockport.edu)

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Thiamine deficiency has been linked to population and reproductive declines in a variety of fish and wildlife species. In Europe the decline of waterfowl has been linked to thiamine deficiency. Many waterfowl congregate on and around Lake Ontario in winter, making it an important region for dozens of species. Some of these species, including scaup and long-tailed ducks, have experienced recent population declines, but the causes for these trends remain uncertain. Importantly, invasive dreissenid mussels have become a key component in many waterfowl diets and these mussels contain high levels of thiaminase, a thiamine degrading enzyme. Our project measured thiamine concentrations in diving and sea ducks harvested from hunters in the Lake Ontario watershed. We received 235 hunter-harvested ducks including greater and lesser scaup, white-winged scoter, black scoter, long-tailed duck, bufflehead, common goldeneye, hooded merganser, common merganser, and red-breasted merganser between November 2021 and January 2022. From each bird, we extracted tissue samples from the quadriceps femoris and liver then quantified thiamine vitamers (i.e., pyrophosphate, monophosphate, and free thiamine) using high-performance liquid chromatography (HPLC) according to Futia et al. (2017). Although there was considerable intraspecific variation in thiamine concentrations, total thiamine concentrations in thigh muscles significantly differed among species ($P < 0.01$) and total thiamine concentrations were greatest in long-tailed duck compared to all other species, except lesser scaup ($P < 0.01$). Our results from thiamine concentrations from the liver are pending but preliminary results suggest a thiamine limitation in this organ. We will also evaluate if harvest date, body condition index, and spatial location are reliable predictors of thiamine concentrations in thigh and liver tissue. Life history implications for waterfowl with reduced or depleted thiamine are largely unexplored in North America but our study hopes to provide baselines of thiamine levels for reference in future work.

Development of Blood Metabolite Index for Mallards

Presented by: Jerad Henson (jhenson@ducks.org)

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Accurately predicting habitat quality for migratory waterfowl is an important aspect of the management of stopover and wintering areas. Birds need enough calories to cope with the increased energetic demands associated with migration and thermoregulation, and managers need to assess if they are meeting those demands. Plasma metabolites can yield valuable physiologic information about the current health state of migrating waterfowl and the habitats they select. As birds accumulate lipids from their food, they build triglycerides (TRIG), and as they burn fat, there is an increase in β-hydroxybutyrate (BOHB), a metabolic breakdown product of triglycerides. These metabolites accumulate in the blood plasma and can be measured to provide a snapshot of whether a bird is depositing lipids or undergoing lipolysis. Plasma metabolite concentrations have been found to fluctuate with daily mass change (DMC) in diving ducks, such as lesser scaup and canvasbacks, and therefore can index foraging habitat quality where the birds were sampled. Our goal was to determine if plasma metabolites could also be used as an index of foraging habitat quality for dabbling ducks like mallards. We assayed blood metabolite concentrations (i.e., TRIG and BOHB, n = 82) from captive, wild-caught mallards maintained on various diets (e.g., plant-, invertebrate, or agricultural seed-based diets) to validate an index of lipid acquisition for determining foraging habitat quality. We found strong correlation between TRIG values above 0.5 mmol L -1 and BOHB and DMC in mallards (R2 = 0.77). We believe that this index could be a useful tool to assess the effectiveness of habitat management and quality. This index will be applied to samples from experimentally-collected or trapped dabbling ducks (e.g., mallard, and northern pintail, green-winged teal) to assess foraging habitat quality relative to wetland management practices, body condition, diet, and other factors on National Wildlife Refuges in the Southeast.

Serosurveillance for H5N1-Subtype Influenza a Virus in Hunting Dogs from Washington State, USA

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Since its emergence in 1996, H5 highly pathogenic avian influenza viruses (HPAIV) have caused an unprecedented panzootic. In 2020, subclade 2.3.4.4b H5N1 HPAIV emerged and spread to multiple continents causing significant mortality in wild birds and poultry, as well as a diversity of wild and domestic mammals. Historically, H5N1 HPAIV infections in dogs have been rare; however, increased mortality has been detected in wild canids and in a single domestic dog during the current (2021-present) North American outbreak. The goal of this study was to test bird hunting dogs for H5 and N1 AIV antibodies. During spring 2023, serum was collected from 194 bird hunting dogs in Washington State and screened for antibodies to AIV using a blocking enzyme-linked immunosorbent assay (ELISA). All seropositive samples were subsequently tested for antibodies to H3N2/H3N8 canine influenza virus (CIV) and H5 and N1 AIV. Dog owners completed a questionnaire at the time of sample collection providing details on their dog(s) hunting activities, vaccination status, and clinical history. Overall, 9.3% (18/194) dogs had antibodies to AIV. Of the seropositive dogs, 14/18 had antibodies to CIV and 4/18 had antibodies to H5 and N1 AIV. None of the 18 seropositive dogs reportedly displayed clinical signs of disease during the previous year. Based on the questionnaire, hunting dogs in Washington State had a high level of risk for H5N1 HPAIV exposure through waterfowl retrieval; however, only ~2% (4/194) had antibodies to H5 and N1 AIV. These four H5 and N1 AIV antibody-positive dogs reported to hunt waterfowl

frequently, hunted during a known HPAIV outbreak over the previous hunting season, and/or had a history of retrieving sick/dead birds (not because of being shot). Collectively, these data suggest hunting dogs can be infected with H5N1 HPAIV, but infection likely requires very high levels of exposure to infected birds.

Effects of Surgically-Implanted GPS/GSM Transmitters on Captive Lesser Scaup (Aythya Affinis) Behavior and Breeding

Presented by: Cheyenne Beach (cbeach1@niu.edu)

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Due to advancements in wildlife tracking technology, researchers are better able to understand the life history of wildlife species often benefiting conservation efforts; however, attaching tracking devices to animals may have negative consequences for individuals. In preparation for a field study involving a diving duck, we investigated the effects of surgically-implanted GPS/GSM transmitters with percutaneous antennas on the behavior and breeding capability of captive, female lesser scaup (Aythya affinis; scaup) at Pinola Aviary in Shreveport, LA. Scaup at the aviary have successfully bred for several years prior to our study and nest in captivity readily. We randomly selected 10 of the 17 captive scaup at the facility to receive transmitters and the remainder were assigned to the control group. In February 2022, a trained veterinarian surgically implanted the transmitters following the protocol established by Olsen et al. (1992). From day 5–95 post-surgery, we conducted daily, 10-minute focal observations of the scaup to quantify and compare grooming, feeding, loafing, and aggressive behaviors between transmitter and non-transmitter birds. We found no difference in the proportion of time birds of each group allocated to these observed behaviors. We recorded the amount of time birds spent on water and found no difference between groups. From day 30–95 post-surgery, we monitored birds daily for breeding and nesting behavior. We identified 5 individuals in the transmitter group and 3 individuals in the control group laying eggs. These results indicate that surgically-implanted transmitters had minimal effects on the behavior and breeding capability of female scaup.

An Assessment of Wood Duck Banding Needs for the Mississippi and Atlantic Flyways

Presented by: Cole Howard (choward43@tntech.edu)

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Sustainable game management requires effective monitoring of population trends and demography. As a heavily harvested species with cryptic forested wetland habitat, monitoring wood duck (Aix sponsa) abundance and vital rates has challenged managers. We used capture-mark-recovery data of preseason banded wood ducks from 2000-2022 to evaluate spatial variation in banding data-derived demographic rates and provide updated monitoring recommendations. We fit a dead-recovery model with Brownie parameterization within a Bayesian framework at varying spatial scales to identify where demographic rates most varied. Bayesian survival analysis revealed latitudinal gradients in wood duck demography within the Atlantic and Mississippi flyways. We identified three regions maximizing inter-region variation and minimizing intra-region variation. Simulations then forecasted how regional banding effort and distribution influence estimate precision. Low banding numbers in some areas of the Atlantic Flyway jeopardizes inference quality. We recommend revised goals by region to achieve mean coefficients of variation ≤7% to best inform harvest regulations. Our approach illustrates the importance of periodically reevaluating monitoring frameworks as population dynamics and management contexts change.

Using Double-Observer and Removal Methodology to Estimate Detection Probability During Upland Nest Drags

Presented by: Hunter VeltKamp (veltk002@umn.edu)

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Researchers commonly use vehicle-towed nest drags to locate dabbling duck nests, but the efficiency of this method has rarely been assessed. During a two-year study of dabbling duck nest survival in northeastern North Dakota, we assessed several potential sources of detection failure while using ATV-towed chain or cable-chain drags for nest searching. Our standard protocol involved teams of 2 ATV operators with no dedicated observer, therefore search-team members had to divide their attention between looking backwards to monitor the drag and looking forward to navigate, so some flushes may have gone undetected because both observers were looking away. We employed independent double-observer methodology to estimate the detection probability for each observer, and considered a variety of variables that might influence their detection probabilities. We found that detection probability varied substantially among observers (from 85.9 to 94.4%), and that it improved throughout the nesting season, presumably due to accumulated experience. Although individual observers often failed to detect flushing females, we estimate that both observers working together detected 1957 out of 1993 (98.1%) available flushing events. Based on our findings, we see no practical need to employ a third crew member as spotter. Then we focused on the probability of a hen flushing from one dragging pass. To measure flushing probability, we used a 2-pass removal estimator based on repeated searches conducted < 30 minutes apart. The leading crew found 761 nests and the trailing crew found 141 nests, for an estimated detection probability of 0.707 (95% CRI 0.636 -0.770) per search event. There was no evidence that detection probability differed by year, search period, or between cable-chain vs. chain only nest drags.

Examining Individual Variation in Samples of Banded Ducks at Delta Marsh, Manitoba

Presented by: Camryn Vestby (cvestby@shaw.ca)

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In the years 2022 and 2023, extensive banding and recovery data were collected at the Delta Marsh, Manitoba, Canada. Although most banding stations collect only date, location, species identification, and sex; our banding station collected additional supplementary data on the marked individuals including: adult molt status, weight, and total head measurements for all individuals at the initial capture. For recaptured individuals, we recorded the band number, adult molt status, and weight. We compare total head measurement across and within years to assess variation in individual quality within sex, age, and species. We compare proportion of individuals within different molt status across and within years as the molt period has been identified as a very important time of natural mortality. We assess variation in weight across and within years. Cumulatively, we provide insight into when timing of removing traps due to the swamping effect of recaptures. Lastly, we compare these sources of variation to the probability of being harvested to test whether these characteristics influence vulnerability in harvest. Throughout the banding period within both years, we observed notable variations in the physical attributes of adult females in their stage of adult molt status and weight; while the adult males exhibited a relatively stable pattern between individuals. We hypothesize that we will be able to provide valuable insight into the relationship between physical characteristics and the likelihood of direct harvest. Therefore, offering a unique opportunity to investigate the movements, survival, and ecological interactions of waterfowl populations over time, aiding harvest management efforts.

Occurrence and Abundance of Wintering Ducks Detected on Aerial Surveys in the Lower Mississippi Alluvial Valley

Presented by: Avery Wissmueller (brian.davis@msstate.edu)

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Mallards and other ducks require diverse resources to meet daily energy and other socio-biological needs to survive during winter. Previous work reported that a complex of landcover types, including 50% agriculture, 20% forested wetlands, 20% emergent herbaceous wetland, 10% and permanent water, attracted the greatest abundance of mallards (Anas platyrhynchos) in Mississippi's Alluvial Valley (MAV). While this 'habitat complex' has been described for mallards, it is uncertain for other species. Herein, we used winter (November-January) detections of mallards and other species obtained from stratified random diurnal aerial surveys in the MAV and related occurrence and abundance of species to aforementioned landcover types along with a measure of landscape complexity and an index of water recurrence. We consistently detected 6 duck species during surveys, including mallards, gadwall (Mareca strepera), northern pintail (Anas acuta), green-winged teal (A. crecca), northern shoveler (Spatula clypeata), and wood duck (Aix sponsa). Complexes with a greater amount of agriculture increased mallard, green-winged teal, and pintail occurrences along with mallard, gadwall, and shoveler abundances. A greater coverage of emergent herbaceous wetlands also increased mallard and pintail occurrences and mallard abundance. Forested wetland prevalence was associated with an increase in mallards and wood duck occurrence. Across species, an increase in landscape complexity either increased occurrence or abundance, except for mallards, which had greater abundances in less diverse landscapes. Finally, complexes more prone to flooding were positively associated with all species occurrence and abundance. Despite different niches and habitat affinities, mallards, gadwall, pintail, and shoveler were in greatest abundances in a complex similar to what has been previously described. However, gadwall and wood ducks required complexes low in agricultural composition. As agricultural land use dominates the MAV landscape, our results signal a continued need for assertive inclusion of natural wetland conservation within MAV habitat complexes.

Effects of Adaptive Harvest Management on Conflicts About Duck Harvest Regulations 1980-2022

Presented by: Pam Garrettson (pam_garrettson@fws.gov)

P.R. Garrettson, U.S. Fish and Wildlife Service
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A formal framework for the adaptive management of waterfowl harvests (AHM) was adopted by the U.S. Fish and Wildlife Service (FWS) in 1995. In addition to concomitantly facilitating learning and management via attempts to acknowledge, model, and ultimately reduce uncertainty, the process can reduce contentiousness and conflict among and between decision makers and stakeholders within the regulation-setting process. However, evidence for reductions in conflict due to adaptive management was heretofore only anecdotal. We examined the portions of Federal Register documents concerning the annual development of duck sport harvest regulations for 1980–2022 to characterize and quantify the number and types of conflicts relative to that occurred prior to and after the implementation of AHM in 1995. We suspected that duck habitat quality and population size could also influence numbers of conflicts. Therefore we incorporated estimates of total ponds and total ducks from the annual Breeding Waterfowl and Habitat Survey, along with a pre-or-post-AHM variable, into Poisson regression models to test for their relative effects. Exponentiated coefficients from the best model indicated a 38% decrease in conflicts per additional 1 million ponds, a 9% decrease per additional 1 million total ducks, and the number of conflicts before AHM was adopted was 1.72-fold greater than after its implementation. We conclude that the formal decision-analytic approach of AHM has reduced conflicting recommendations for annual duck harvest regulations by clarifying the objectives for duck harvest management, alternatives under consideration, and decision rules for interpreting data, while simultaneously representing competing hypotheses about population regulation.

Temporal Relationships Between the Migratory Bird Hunting and Conservation Stamp and the Duck Breeding Population: An Update of Vrtiska Et Al. (2013)

Presented by: Christopher Chizinski (cchizinski2@unl.edu)

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Historically, the sales of the Migratory Bird Hunting and Conservation Stamp (aka, federal duck stamp) were in sync with the duck breeding population. In the early 1990s, a disconnect between stamp sales and the duck breeding population was observed. Vrtiska et al. (2013) speculated that annually, there were about 600,000 fewer duck stamps sold than expected between 1995 and 2008, which equated to a loss of US$126 million in gross revenue and 42,500 to 80,900 fewer hectares of habitat protected. It has been over a decade since the study by Vrtiska et al. (2013), so we revisited the relationship between federal duck stamp numbers and the duck breeding population. Data indicated that from 2003 to 2015, there was continued divergence between federal duck stamps sold and the breeding duck population. After 2015, the trend reversed, with the number of waterfowl hunters increasing while duck breeding populations declined. Interestingly, the annual change rate in the duck breeding populations and federal duck stamps has grown since 2005, harkening back to what occurred during the 1950s-1980s. Alternatively, the period from the 1980s until 2005 had a low rate of change. Developing and implementing programs and policies to increase participation in waterfowl hunting may be paying off in slowing the decline of federal duck stamp sales. We will need to assess how the declining duck breeding populations influence federal duck stamp sales and, consequently, future wetland and upland habitat conservation.

Harlequin Duck Harvest Closure in Washington State

Presented by: Kyle Spragens (kyle.spragens@dfw.wa.gov)

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Beginning in 2019, despite national trends of declining waterfowl hunter participation and repeated calls to “simplify regulations”, Washington State began experiencing a notable increase in sea duck hunters, days afield, and harvest targeting unique species such as Harlequin Duck. Eleven species of sea duck can regularly be found in Washington’s waters of the Salish Sea, with seven species requiring waterfowl hunters to carry and record a mandatory harvest report card to document this narrow user-group of duck hunters. The author will provide background context, timelines, considerations and consequences of the closure on Harlequin Duck taken at state discretion beginning in the 2022-2023 duck hunting season. This case scenario provides a unique insight that contradicts common themes in waterfowl hunter recruitment, retention, and reactivation activities, and provides an important example to waterfowl managers trying to accommodate an assorted range of waterfowl hunters.

Hunting as a Selective Force on Migration Phenology and a Mechanism for 'Stale' Ducks

Presented by: Bradley Cohen (bcohen@tntech.edu)

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Contemporary recreational hunting, especially in North America, is a novel selective pressure on wildlife populations that can change phenotypes across several generations. For waterfowl, sustained and increasingly intense hunting may drive population-level changes by favoring heritable or learned behaviors that reduce mortality risk. We coupled molecular and behavioral tracking data to explore whether autumn migration phenology of mallards (Anas platyrhynchos) could be under selection for earlier and faster migrations. We used GPS monitoring and genomic sequencing of 90 individuals captured in Arkansas and Tennessee during winters 2019 through 2022. We calculated autumn migration behaviors—including migration speed and arrival timing—using bivariate segmentation. We subsequently correlated behaviors to single nucleotide polymorphisms using genome-wide associations to explore possible genetic predispositions for certain migratory phenotypes. Earlier-arriving mallards had higher winter site fidelity and occupied lower latitudes. These behaviors reduced exposure to the number of days hunted compared to late migrators. We hypothesize earlier migrants develop strong cognitive maps for specific non-breeding areas, relocate less often thereafter, and are consequently less susceptible to harvest. Conversely, mallards who migrate multiple times and arrive to wintering termini later must continually develop landscape-level learning, which conflicts with anti-hunter responses. Perhaps risk-reduction through migratory phenotypes is a genetically-derived behavioral syndrome developed unintentionally as a consequence of contemporary recreational hunting practices in the Lower Mississippi Alluvial Valley. Integrating across diverse datasets, analyses, and experience, we cogitate whether sustained hunting pressure favors heritable or learned migratory phenotypes that reduce hunting mortality risk. Coupled with warmer winters, we discuss the possibility and evidence suggesting selective migratory behaviors may contribute to reduced harvest and hunter dissatisfaction in the mid- and deep-south, despite record breeding populations.

Tier II Duck Hunting Regulations in Nebraska and South Dakota

Presented by: John McKinney (john.mckinney@nebraska.gov)

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Relative to other forms of hunting, duck harvest is managed by regulations that are species- and sex-specific that require hunters to identify ducks in flight. These regulations are often cited as inhibiting, or in some instances prohibiting, new hunters to try duck hunting. The two-tier duck hunting regulation experiment went into effect during the 2021-2022 hunting season in Nebraska and South Dakota, where hunters could choose between a simplified three-bird daily bag limit with no species or sex restrictions (Tier-II), or the traditional six-bird daily bag limit with species and sex restrictions (Tier-I). We conducted a survey of Tier-II hunters following each hunting season. Hunters most frequently reported they had hunted ducks in previous years, but the majority of hunters claimed that they had chosen Tier-II because they were not confident with their duck identification skills. Those who had never hunted ducks before were more likely to agree that using Tier-II helped them develop their duck identification skills ($\chi^2 = 58.37$; $P < 0.01$; OR = 3.97). Qualitative coding of hunter interviews identified six major themes for Tier II participation including “helped me learn,” “want more opportunity,” “three is enough,” “disinterested in identification,” “species specific,” and “generally displeased”. The state of future waterfowl-hunter participation is a serious concern of wildlife agencies across the United States. Our results suggest that a significant proportion of new waterfowl hunters make use of the three-duck bag limit, and the two-tier system may relieve hunting-constrains in a meaningful way. Wildlife agencies may want to consider the effects of the two-tier system on hunter participation in the future as well as track how hunters transition between bag-limit regulations from year-to-year.

Evaluating Deterrents to Reduce Depredation of Wood Duck Eggs in Nest Boxes

Presented by: Emily Miller (emiller7@esf.edu)

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Wood ducks (Aix sponsa) are secondary cavity nesting species that also nest in artificial nest boxes. Since the early 20 century, nest boxes have been widely deployed in North America to increase suitable nesting space for wood ducks and help recover populations. Placement of nest boxes over water, away from overhanging vegetation, and equipping nest boxes with a predator guard beneath the box are common practices used to lessen avian, reptile, and mammal predators from accessing boxes. Despite use of these tactics, we found that Eastern rat snakes (Pantherophis alleghaniensis) and woodpeckers (Picidae) were primary predators of wood duck eggs in boxes in North Carolina and South Carolina. Accordingly, we designed and implemented experiments to deter snakes and woodpeckers using a commercial brand of snake repellent pellets and a plastic raptor decoy, respectively. Male and female snakes that accessed boxes were large averaging > 1.3 m. Photographic evidence revealed that snakes climbed nest box posts/poles and thrusted their anterior body atop predator guards to continue their ascent into the box. We recorded 671 nest failures of which rat snakes and woodpeckers accounted for 39.9% (n = 268) and 22.4% (n = 150), respectively. Snakes consumed at least 649 eggs that we observed as protuberances in their stomachs. Our experiment using commercial snake repellent pellets did not significantly deter snakes. Placing a plastic hawk effigy atop nest boxes when hens were incubating ≥12 days increased nest success ($P < 0.001$). We suggest management implications and recommend replication of these experiments where snakes and woodpeckers are important predators of box-nesting wood ducks.

Productivity of Wood Duck Clutches Parasitized by Hooded Mergansers and Black-Bellied Whistling-Ducks

Presented by: Dylan Bakner (dylanbakner5567@gmail.com)

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Historically, hooded mergansers (merganser) were the most common interspecific brood parasite of wood duck nests in the southeastern United States. However, the recent northward expansion of black-bellied whistling-ducks (whistling-duck) has resulted in interspecific brood parasitism (IBP) occurring between these two species. We monitored nest boxes in Louisiana to evaluate the influence IBP had on wood duck daily nest survival rate (DSR) and duckling recruitment. We monitored 1,206 wood duck nests from 2020−2024 and found 98 (8.1%) were parasitized by mergansers and 134 (11.1%) by whistling-ducks. Clutch size had a positive influence on DSR, but a significant quadratic term indicated an asymptotic effect at ~28 eggs. Parasitic egg-laying by mergansers lowered DSR, while DSR for nests parasitized by whistling-ducks was comparable to clutches containing only wood duck eggs. We considered 2,124 marked female ducklings and 541 banded adult females to estimate a duckling recruitment probability for the entire study period. We recaptured 49 ducklings as recruits; 6 (12.2%) hatched from clutches parasitized by mergansers, 1 (2.0%) from a clutch parasitized by a whistling-duck, and 42 (85.7%) from clutches containing only wood duck eggs. The duckling recruitment probability was 0.038. Nest initiation date had a negative effect on recruitment and was the only important covariate considered. Given only ~8% of wood duck nests contained merganser eggs, we conclude IBP had no detrimental effect on DSR. We hypothesize larger clutch sizes buffered against nest abandonment, because without the addition of parasitic eggs, clutches would be depleted by red-bellied woodpeckers. The lower DSR of clutches parasitized by mergansers is potentially linked to a high abundance of early-season parasites that produce “dump nests,” which are often abandoned. Duckling recruitment was unaffected by parasitism and most recruits hatched from nests initiated earlier in the season. Wood duck productivity in Louisiana appears to be unaffected by IBP.

A Study on Wood Duck Population Size and Harvest Effects: Unveiling the Complexities of Wood Duck Mortality Dynamics

Presented by: Andrew Greenawalt (andrew.greenawalt@wildlife.ca.gov)

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In North America, waterfowl hunting is regulated as a function of population size, where harvest is liberalized during times of high abundance and restricted when populations are low. However, population size is regulated by factors other than harvest, and often covaries with both harvest and survival probabilities. Wood ducks (Aix sponsa) are a unique species of waterfowl that are heavily reliant on forested wetland habitats, and they are hunted legally during autumn and winter months throughout North America. The nature of their preferred habitat makes it difficult to detect individuals through traditional aerial surveys, and therefore poses challenges for estimating abundance. Here we used 57 years (1961-2018) of wood duck band recovery data and total harvest data to predict wood duck population size in the Upper Mississippi Great Lakes Region using a Lincoln capture-mark-recovery estimator. We examined how our Lincoln estimates compared to breeding abundance estimates from aerial surveys in Minnesota, Wisconsin, and Michigan, after correcting for the different spatial extent of each method. Next, we included wood duck Lincoln estimates as a covariate in a Brownie dead recovery model to test for density dependence in wood duck survival and harvest probabilities. We also examined how other factors, including: hunter abundance and harvest regulations (e.g., season lengths and bag limits) affect wood duck mortality dynamics. We show that Lincoln estimates were on average 6-11 times greater than the combined aerial surveys. We also show that wood duck population size has a negative effect on the per capita risk of harvest, where harvest probability declines with increasing abundance. Additionally, wood duck population size and hunter abundance have much stronger effects on wood duck harvest mortality than harvest regulations. However, in most cases harvest regulations had a positive effect on harvest mortality throughout the three lake states. The findings herein have broadened our understanding about the complexities between harvest effects and wood duck population dynamics.

Wood Duck Artificial Nest Box Selection in the Delmarva Peninsula

Presented by: Blake Struthers (blakestr@udel.edu)

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Factors influencing female wood duck nest site selection have received ample attention from wildlife managers for decades. The enthusiasm behind such rigorous study was driven by a drastic decline in wood ducks in the early 1900's and enabled by the acceptance of artificial nesting structures for research purposes. Wood ducks exhibit high nest site fidelity, and some populations are even non-migratory. This behavior emphasizes the importance of local scale research as spatial and temporal variation across localities may preclude landscape scale generalizations about wood duck nesting ecology. We examined nest box use vs. availability data from 2018-2021 at seven study areas with wood duck nest box programs in Maryland and Delaware where a lack of information on wood duck nesting ecology exists. We analyzed 29 habitat and box characteristics to determine important factors related to nest box selection with “use” defined as ≥1 wood duck egg laid in a nest box. The number of available nest boxes varied by year but reached a maximum of 301 in 2021 for a total of 949 available nest boxes combined over all years. Female wood ducks preferred new boxes that were placed in highly visible locations and erected individually rather than in duplex units. This corroborates previous research that wood ducks rely strongly on visual acuity when selecting nest sites and provides evidence that females prefer to distance themselves from conspecifics when nesting. These findings may be useful to wildlife managers interested in optimizing nest box placement to increase local wood duck populations, especially in the Delmarva Peninsula.

The Influence of Shavings on Wood Duck Reproductive Ecology and Eggshell Bacteria

Presented by: Jacob Shurba (jshur1993@gmail.com)

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Wood ducks (Aix sponsa) are secondary cavity nesters that use natural cavities and artificial nest boxes, the latter of which has been attributed to the recovery of their populations across the southeastern United States. Continual use of nest boxes causes of buildup of bacteria, parasites, and other pathogens. Best management practices to avoid the accumulation of these deleterious organisms include the periodic removal of old nesting material (i.e., wood shavings) and replacement with fresh material. No studies have been performed on the effects of shaving material on nest box use and selection, nest success, and bacterial growth. We monitored 142 and 123 nest boxes in Florida and Georgia, respectively, and filled a random sample with aspen or cedar shavings. We then swabbed the surface of eggs from 29 and 21 nest boxes during 2020 and 2021, respectively, to screen for culturable bacteria. We detected no effect of shaving type on nest box selection, nest success, or egg surface bacterial growth. We found between 3–8 (1–123 CFUs/box) and 1–8 (3–382 CFUs/box) bacterial colony types among the Georgia and Florida samples. We detected no effect from shaving type on wood duck reproduction or bacterial growth in our sampled nest boxes. We concluded that both shaving types are suitable nesting materials for box-nesting wood duck populations throughout our study area.

Method for Evaluating Cavity Suitability for Nesting Wood Ducks

Presented by: Cindy Von Haugg (cvonhau@clemson.edu)

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The intensity and resource requirements of cavity surveys have hindered the practicality of cavity-nesting wood duck (Aix sponsa) studies in the southeastern U.S. The primary difficulty stems from the need to climb trees, which omits the ability to measure cavities on limbs or in trees unsafe to climb. To overcome this issue, we developed a method allowing external and internal cavity dimension measurements to be taken from the ground. Our approach uses a device consisting of a 1) telescopic pole, 2) wireless cavity inspection camera with a monitor, and 3) reference scale allowing an object of known length to be viewed and recorded inside the cavity. We tested our method using simulated cavities (n = 20), assessed accuracy by comparing the estimated and actual measurements and evaluated precision between 2 observers. The differences between estimated and precise measurements were minimal. There was no difference between observers for entrance width, entrance height, platform width, and platform length ($P > 0.05$), but there was a difference for platform depth ($P = 0.016$). The time to complete a single cavity survey in the field (n = 37) averaged 12.2 (SE = 6.9) minutes. We used this method to record cavity measurements and determine suitability while evaluating the forest and tree characteristics indicative of cavities and their relative abundance across South Carolina's five dominant forest types. We recorded forest metrics of 20-m radius plots (n = 160), trees with >22 cm diameter at breast height (n = 4,631) and suspected cavities (n = 226). Using this method, we hope to increase our understanding of the reproductive ecology of cavity-nesting hens, especially across the southeastern portion of their range.

Egg Morphometrics and Egg Hatchability in Box-Nesting Wood Ducks

Presented by: Hunter Mentges (hem357@msstate.edu)

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The avian eggshell is among the most impressive and unique structures in the natural world. However, in wild birds, little is known about the relationship between egg morphometrics and hatchability. Chicken eggs are well studied because of their economic importance and the greatest hatchability occurs in medium-sized eggs compared to small and large eggs. In lesser snow geese (Anser caerulescens), goslings hatched from heavier eggs survived starvation longer than goslings hatched from lighter eggs. Given this intriguing but relatively understudied topic, we studied the egg dynamics of box-nesting wood ducks (Aix sponsa) in Mississippi. Understanding egg hatchability in this species may be especially important as wood ducks commonly share nest space with hooded mergansers (Lophodytes cucullatus) and black-bellied whistling ducks (Dendrocygna autumnalis). Moreover, ducklings produced from larger eggs often survive better than those emerging from smaller eggs. To better understand egg hatching characteristics in wood duck eggs, we marked wood duck eggs uniquely with non-toxic markers and collected mass (g), length (mm), and width (mm) measurements from each along with other clutch metrics. We will analyze data from successful nests and treat eggs as either hatched or unhatched. We will then use variables of clutch size, egg mass, egg length, and egg width to examine how they ultimately affect the hatching probability of an individual egg.

Ducklings in a Dangerous Spacetime: Investigating the Relationship Between Personality and Growth Across Ontogeny in Captive-Reared Wood Ducks (Aix sponsa)

Presented by: Mitch Hinton (hinton.mitch@gmail.com)

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Individuals within a population vary in the range and kind of behaviors they exhibit. This variation, when consistent across time and/or context, has been termed animal personality. How and why consistent individual differences are maintained within populations when they have far-reaching fitness consequences remains a fundamental inquiry. Links between individual state and behavior have been hypothesized as an important component in the maintenance of behavioral variation. Furthermore, understanding the development of consistent differences in state, behavior, and their relationship is pivotal in addressing this question. We aimed to longitudinally assess the relationship between growth and personality across ontogeny in captive-reared Wood Ducks (Aix sponsa). We collected eggs from wild populations in the Central Valley of California and artificially incubated them at the University of California, Davis. We reared individuals in a controlled environment, collecting morphometric and behavioral data on a weekly basis using standardized assays. We found that individual differences in behaviors associated with sensitivity to predation risk remained relatively consistent across development. Duckling size consistently varied across development and was significantly related to behavioral expression among-individuals, though the relationship was age dependent. Experimentally increasing the perception of predation risk within the developmental environment significantly decreased growth rates but had a limited direct effect on behaviors and their relationship with duckling size. In the wild, we've observed a positive correlation between hatchling size and recruitment. Coupling this with the observation of high rates of mortality due to predation, the dynamic relationship between growth and behavior suggests that individual variation in behavior influences duckling survival. Moreover, individual differences at hatch may place ducklings on life-history trajectories that influence not only survival, but reproductive success. Elucidating the role of personality in duckling survivorship and its carry-over effects on reproduction would serve to improve our understanding of population dynamics in a variable landscape.

Limited Evidence of Biased Offspring Sex Allocation in a Cavity-Nesting Conspecific Brood Parasite

Presented by: Caitlin Wells (caitlin.wells@colostate.edu)

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Sex allocation theory predicts that individual mothers should bias investment in offspring toward the sex that will yield them higher fitness returns, and one form of this investment may be biased offspring sex ratios. Sex allocation has been well-studied in birds with cooperative breeding systems, with theory on local resource enhancement and production of helpers at the nest, but little empirical work has developed or tested sex allocation predictions in birds with brood parasitic breeding systems. Wood ducks (Aix sponsa) are a conspecific brood parasite, and rates of parasitism appear to increase with density. Because female wood ducks are philopatric and nest sites are often limiting, local resource competition (LRC) theory predicts that females should overproduce male offspring—the dispersing sex—when competition (density) is high. However, the unique features of conspecific brood parasitism generate alternative predictions from other sex allocation theory, which we develop here. We experimentally manipulated nesting density of female wood ducks in four populations from 2013-2016, and studied the resulting sex allocation of >2000 ducklings. In contrast to predictions we did not find overproduction of male offspring by females in high-density populations, females in better condition, or parasitic females; modest support for LRC was found in overproduction of only female parasitic offspring with higher nest box availability. These findings demonstrate that despite expectations for offspring sex allocation in cavity-nesting, conspecific brood parasites, in which other females are both competitors for local resources (nest sites) and also resources themselves (as opportunities for parasitism), biasing offspring sex may not possible or profitable for some species.

Postbreeding Ecology of Wood Ducks in the Illinois River Valley

Presented by: Andrew Gilbert (agilb849@illinois.edu)

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The wood duck (Aix sponsa) consistently ranks high in the duck harvest for both Illinois and the Mississippi Flyway. While substantial research has been done on wood ducks, especially their breeding ecology, few studies have investigated the postbreeding ecology of the species. We captured and marked wood ducks with either a very high frequency (VHF) radio transmitter or a solar charged global system of mobile communication (GSM) transmitter during the postbreeding period in late July and August 2018–2020. Capture locations were within the La Grange Pool of the Illinois River extending from near Pekin, IL to the La Grange Lock and Dam near Meredosia, IL. We used standard radio-telemetry techniques to track wood ducks to determine cover type use, home range size, daily movement patterns, survival, and migration chronology. Home range size (95% minimum convex polygon) for wood ducks averaged 6,820 ± 572 ha and did not differ significantly by age, sex, or transmitter type. Daily movement distances between consecutive diurnal and nocturnal periods averaged 2,906 ± 28 m. Wood ducks primarily used wetlands with emergent vegetation (54.1%) and woody vegetation (37.7%). Additionally, the most frequently used wetland type by wood ducks was impounded wetland (57.6%), followed by lake (12.5%), pond (12.4%), riverine wetland (7.8%), and ditch (6.1%).Wood duck survival during the postbreeding period was 0.79 (0.74-0.84) and survival increased with increased river level. Average departure date of wood ducks leaving the Illinois River Valley was 27 October, and adult male wood ducks left the study area 11–16 days earlier than the other age and sex cohorts. Our findings will help guide conservation decisions for wood ducks and other waterfowl by providing information to better understand wood duck ecology during the postbreeding period.

Evaluating Approaches for Integrating Species Distributions in Spatial Conservation Planning

Presented by: Jacob Straub (jstraub@brockport.edu)

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Map-based decision support tools that use species distributions are an important means of identifying priority areas for conservation. The 2020 Wisconsin Waterfowl Habitat Conservation Strategy (WWHCS) uses a decision support tool to identify priority ecological landscapes and watersheds to guide waterfowl habitat projects. The WWHCS decision support tool relies on waterfowl habitat suitability layers derived through expert opinion in lieu of species distributions, a common approach in decision support tools. Given the inherent subjectivity of expert opinion, data-driven species distributions such as those available from citizen science projects, could provide more accurate information and better identify areas important for waterfowl conservation. Here, we explore the application of relative abundance products available through the eBird Status and Trends project as an alternative to expert-derived habitat suitability layers in the WWHCS decision support tool. Our objectives were to compare seasonal species distributions derived from habitat suitability models (expert-derived) and species distribution models (eBird-derived), and determine whether differences influenced decision support tool prioritizations. Correlations between expert- and eBird-derived distributions were generally low to moderate for the breeding and fall layers (ρ: -0.03–0.76), and lowest for the spring (ρ: -0.49–0.72). There was low agreement between top-ranked ecological landscapes (40%) and watersheds (28%) from the expert- and eBird-derived versions of the decision support tool. Overall, our results suggest the decision support tool may benefit from incorporating data-driven species distributions. However, additional work validating eBird relative abundance against professional surveys (e.g., aerial counts) and empirical studies evaluating waterfowl habitat selection and vital rates are important future considerations for the WWHCS decision support tool and waterfowl habitat conservation in Wisconsin.

Human-Induced Range Expansions Result in a Hybrid Zone Between Mottled and Mexican Ducks in South Texas Brush Country

Presented by: Philip Lavretsky (plavretsky@utep.edu)

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Landscapes are consistently under pressure from human-induced ecological change, often resulting in shifting species' distributions. For some species, changing geographical breadth of their niche space results in matching range shifts to regions other than those in which they were formally found. We employ a population genomics approach to assess the potential conservation issues from purported range expansions into south Texas Brush Country of two sister species of ducks, mottled (Anas fulvigula) and Mexican (A. diazi) ducks. Both ducks are non-migratory, with the mottled duck ranging across freshwater and brackish marshes of the Western Gulf Coast region of Louisiana and Texas, while the Mexican duck adapted to the wetlands of the Chihuahuan Desert. Interestingly, both species are increasingly being recovered outside their stated ranges, with the northeastward and westward expansions of Mexican and mottled ducks, respectively, perhaps bringing these two species back into contact today. We assessed genetic ancestry using thousands of nuclear loci of sampled Mexican- and mottled-like ducks from across south Texas, and report that they are indeed moving into this region. Specifically, genetically pure western gulf-coast mottled ducks were confirmed as far west as the county of La Salle, Texas, while Mexican ducks were found across Texas counties near the USA-Mexico border. Importantly, the first confirmed Mexican x mottled duck hybrids were found in-between these regions that likely represents a recently established contact zone. Together, we conclude that some proportion of mottled ducks are indeed expanding their range into more interior areas of Texas away from their native habitat of the Gulf Coast region that is potentially a response to declining habitat quality. These data will not only be used to revise operational survey areas for mottled ducks, but will require continued monitoring to follow how this recent contact event may impact both species in this region.

Waterfowl Survey Design and Species-Habitat Relationships in the Ring of Fire Region of Ontario

Presented by: Matt Dyson (matt.e.dyson@gmail.com)

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Information connecting species-habitat associations and abundance are critical to effective conservation planning. While distribution and abundance information for waterfowl is well known across North America, there remain large gaps in survey coverage. Many of these regions have been previously considered pristine, but face increasing pressure from land use and climate change. Therefore, having a baseline understanding of species-habitat associations and abundance will fill key knowledge gaps to understand how managers can better anticipate and respond to future population change. We developed a survey methodology for monitoring the abundance of breeding waterfowl associated with the proposed Ring of Fire mineral development region in Ontario's Far North. We used a stratified random sample of 60 plots (5 km x 5 km) across a habitat axis that covered a gradient of lake area, lake perimeter, and river length, thought to be important for explaining the distribution and abundance of waterfowl. We surveyed 44 plots in 2022 and 60 plots in 2023. We observed indicated breeding pairs for 17 species of waterfowl, with mallard and ring-necked duck being the most abundant species. We developed general additive models (GAMs) to explain species-habitat relationships for 12 species of waterfowl and used these models to predict total abundance and distribution of ducks within the study extent. We will compare and contrast across species-habitat associations and discuss implications for land use change and climate change to impact waterfowl populations in this region. In addition to contributing information to the distribution and abundance of waterfowl in this previously under surveyed region, data obtained from these surveys will be used to inform a Regional Impact Assessment within the Ring of Fire mine claims (and surrounding) area as well as for the 3rd Ontario Breeding Bird Atlas.

Abundance and Distribution of Blue-Winged Teal in California: A Review of the Last 150 Years

Presented by: Cliff Feldheim (cfeldheim@ducks.org)

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We reviewed museum collections, historical records, old and recent publications, eBird, and Christmas Bird Count data to assess the wintering and breeding abundance and distribution of Blue-winged Teal (Spatula discors) in California from the late 1870s to 2020. In general, Blue-winged Teal populations have changed from being considered a rare transient and winter visitor that was believed to not breed in California, to occurring at predictable locations in the winter and spring with breeding records in every non-mountainous region of the state. Between 2016 and 2018, 11 Blue-winged Teal were captured, and GSM backpack transmitters were attached during winter at Bridgeway Island Pond in West Sacramento. These birds migrated to breed in the San Joaquin Valley, Northeastern California, Oregon, Idaho, and Alberta with 1 bird returning to the same wintering location as capture the following winter. This represents the first documentation of a Pacific Flyway population of Blue-winged Teal.

Evidence of Shifts in the Spatial Distribution of Harvested Gamebirds from the Prairie Potholes Over Time

Presented by: Daniel Gibson (gibsond@vt.edu)

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The timing and flight path of fall migration of waterfowl impacts hunter success and satisfaction, and there is ample evidence to suggest that fall migratory behavior may be changing. Here, we constructed a spatially-explicit mark-recovery model that used recoveries of dabbling ducks banded throughout the western (Alberta and Montana), central (Saskatchewan and the Dakotas), and eastern (Manitoba and Minnesota) portions of the Prairie Pothole Region (PPR) to assess whether harvest rates (κ), or the spatial distribution of harvest (i.e., state or provincial-scale harvest rates), varied among species and breeding areas from 1960–2022. Of the three species considered, mallards were harvested at the greatest rate ($\bar{\kappa}$_HY: 0.17; $\bar{\kappa}$_AHY: 0.11), followed by pintail ($\bar{\kappa}$_HY: 0.10; $\bar{\kappa}$_AHY: 0.04), and blue-winged teal ($\bar{\kappa}$_HY: 0.05; $\bar{\kappa}$_AHY: 0.03). Spatial distribution of harvest shifted through time, but these patterns differed among species and breeding regions. For example, harvest rates of pintail and mallards from the central and eastern PPR declined locally (i.e., within the PPR) as well as near the terminus of the migratory range (i.e., Gulf Coast), but have increased in the interior portions of the Central and Mississippi Flyways, potentially indicating a northward shift in non-breeding range use or in the timing or locality of hunter efforts. In contrast, harvest rates of blue-winged teal from the western and central sections of the PPR increased throughout the Gulf Coast, but remained stable (interior Central and Mississippi Flyways) or declining (PPR) in other parts of their non-breeding range. Overall, these preliminary results provide additional evidence that migratory connectivity of waterfowl populations shifted, and suggest that apparent reductions in regional non-breeding abundance may result, at least in part, from biases introduced by shifts in non-breeding and migration habitat use, not reductions in continental-scale abundance.

Factors Driving Long-Term Changes in Duck Harvest Distributions in the Central and Mississippi Flyways

Presented by: Bram Verheijen (bramverheijen@missouri.edu)

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Geographical distributions of migrating and wintering ducks are likely influenced by climate, habitat availability, and land-use. Shifts in wetland availability related to changes in climate, land-use, and other factors could lead to temporal mismatches in habitat provision and harvest management decisions if informed by historical duck distributions. Using band recoveries from 1960–2019, we assessed changes in distributions of blue-winged teal (Spatula discors), mallards (Anas platyrhynchos), and northern pintails (Anas acuta) during autumn and winter in the Central and Mississippi Flyways. We used kernel density estimators to evaluate temporal shifts in the centroid location, area, and overlap of distributions by month, and overlaid spatial weather and land-use data layers with band recovery distributions from the 1980s versus the 2010s. During December and January, centroids of mallard and pintail recovery distributions moved north by >550 km for some subpopulations. Northern pintail isopleths were >2x larger in December and >1.5x larger in January during the 2010s versus the 1960s. Finally, no metric for blue-winged teal changed noticeably during any month. Preliminary results for December and January show areas newly used in the 2010s had greater increases in temperature (0.8 vs. 1.1°C) and cropland cover (0.1 vs. 1.0%) than areas abandoned since the 1980s. Woody wetland cover increased (0.4%) and emergent herbaceous wetland cover decreased (−0.3%) in abandoned areas, whereas change in either wetland cover type was minimal for newly used areas. Distributional changes could alter the timing of local habitat management and provision decisions and could reduce hunting and recreational opportunities or quality for some species in southern states. Climate, land-use, and changes in breeding population and subpopulations likely all influence autumn and winter distributions of ducks. Understanding temporal, interspecific, and intraspecific variation in waterfowl distributions and its drivers will help inform future conservation and management efforts at broad geographic scales.

Assigning Harvested Waterfowl to Geographic Origin Using Isoscapes: What Is the Best Analytical Approach?

Presented by: Jackson Kusack (jkusack@uwo.ca)

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Establishing links between breeding, stopover, and wintering sites for migratory species is important for their effective conservation and management. Isotopic assignment methods used to create these connections rely on the use of predictable, established relationships between the isotopic composition of environmental hydrogen and that of the non-exchangeable hydrogen in animal tissues, often in the form of a calibration equation relating feather (δ2Hf) values derived from known-origin individuals and amount-weighted long-term precipitation (δ2Hp) data. The efficacy of assigning waterfowl to moult origin using stable isotopes depends on the accuracy of these relationships and their statistical uncertainty. Most current calibrations for terrestrial species in North America are done using amount-weighted mean growing-season δ2Hp values, but the calibration relationship is less clear for aquatic and semi-aquatic species. Our objective was to critically evaluate current methods used to calibrate δ2Hp isoscapes to predicted δ2Hf values for waterfowl. Specifically, we evaluated the strength of the relationships between δ2Hp values from three commonly used isoscapes and known-origin δ2Hf values three published datasets and one collected as part of this study, also grouping these data into foraging guilds (dabbling vs diving ducks). We then evaluated the performance of assignments using these calibrations by applying a cross-validation procedure. It remains unclear if any of the tested δ2Hp isoscapes better predict surface water inputs into food webs for foraging waterfowl. We found only marginal differences in the performance of the tested known-origin datasets, where the combined foraging-guild-specific datasets showed lower assignment precision and model fit compared to data for individual species. We recommend the use of the more conservative combined foraging-guild-specific datasets to assign geographic origin for all dabbling duck species. Refining these relationships is important for improved waterfowl management and contributes to a better understanding of the limitations of assignment methods when using the isotope approach.

Integrating GPS Telemetry and Δ2H Isoscapes to Identify Breeding Ground Fidelity and Dispersal by Mallards

Presented by: Drew Fowler (dfowler@agcenter.lsu.edu)

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Waterfowl are unique among migratory birds because they pair during nonbreeding seasons and females lead selected mates to their natal or previous breeding area (i.e., fidelity). Therefore, breeding fidelity is assumed to be more likely in females than males. However, fidelity and conversely, dispersal, may covary with age and habitat conditions. Importantly, understanding process and likelihood of breeding fidelity may allow natural resource managers to anticipate changing species distributions and optimize banding and other survey operations. Estimates of breeding site, regional fidelity, and dispersal are limited even for well-studied species like mallards (Anas platyrhynchos). We examined breeding fidelity by mallards using a novel integrated approach using GPS-GSM telemetry to monitor breeding behavior and settlement patterns in year t and estimated breeding origins from stable isotope signatures of individuals in year t – 1. Specifically, we captured male and female juvenile mallards in western Tennessee during winters 2020 –2021 (historic drought) and 2021 –2022. We monitored and identified breeding behaviors using a biologically-based behavioral segmentation analysis in year t and assigned probabilistic natal or summer origins the year prior t – 1 using stable-hydrogen isotope deuterium (δ2H) values measured from metabolically inert flight feathers at the time of capture in year t. Our preliminary results suggest that breeding source origins of juvenile mallards are latitudinally diverse and exhibit varying degrees of subsequent breeding site fidelity, perhaps relative to environmental conditions evidenced by more females using more stable wetland conditions (Great Lakes) during drought year but potentially emigrating to the Prairies the following year when wetland conditions improved. Our approach could be useful to identify broader breeding season behaviors across regions that may optimize banding and survey efforts by informing site and breeding fidelity and thus breeding season distributions relative to habitat conditions. Integrating molecular techniques to identify possible genetic

substructuring may also be useful as would incorporating winter site fidelity into analyses to tease apart potential mechanisms of breeding versus winter fidelity.

Natal Origins of Mallards in the Atlantic Flyway of North America: Implications for Conservation and Management

Presented by: Samuel Kucia (samuel.kucia@sdstate.edu)

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Appropriate management and conservation of migratory species require knowledge of connectivity between natal or breeding sites and stopover or wintering sites. For game species, such as waterfowl, knowledge of source areas that produce juveniles, which are available for harvest in the autumn-winter, is of considerable interest. External markers have long been used in mark-recapture studies to identify breeding grounds of waterfowl. However, this approach is biased towards regions of marking effort and is logistically difficult in remote locations. Harvest management of Mallards (Anas platyrhynchos) in the U.S. portion of the Atlantic flyway has assumed that the majority of harvested birds in the U.S. were produced there. We tested this assumption by inferring regions of natal origins of juvenile Mallards (n = 1,254) harvested during the 2018–19 and 2019–20 hunting seasons in all states in the Atlantic flyway using stable-hydrogen isotope analyses of breeding-ground grown feathers (δ2Hf). We created a species-specific feather isoscape and applied a Bayesian assignment approach to identify probable regions of origin. We determined 64% of our sample had δ2Hf consistent with origins in Canada versus the U.S. Our data suggested all states harvested Mallards that had origins from the U.S. and Canada throughout their entire hunting season. Our results contrast with long-term breeding population estimates which suggest the majority of breeding pairs of eastern Mallards occur in the U.S. We recommend further investigation into reasons for disparities in national natal origins of harvested Mallards.

Combining Stable Isotopes and Band Returns to Derive Origins of Great Lakes Waterfowl

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Harvest derivations typically rely on leg-band returns, but derivations using stable-hydrogen isotopes within feathers are quickly emerging in waterfowl research. While band returns provide precise individual-level connections, they can be logistically and financially difficult to obtain, as banding necessitates pre-season capture and subsequent encounter during the fall harvest. Further, banding efforts may not sample the entire breeding range for many northern breeding waterfowl. Alternatively, stable isotopes are a naturally-occurring intrinsic marker that requires no initial capture. While stable isotopes allow for information from all captured individuals, these derivations can be less precise as they are reliant on climate patterns. Our objective was to directly compare harvest derivations based on stable-hydrogen isotopes within feathers and leg-band returns, to evaluate potential biases. For this, we focused on a single representative harvest region, the Great Lakes, and collected feathers, using the species composition and parts collection surveys, from ten species of harvested waterfowl (American Black Duck, Bufflehead, Canvasback, Greater Scaup, Green-winged Teal, Lesser Scaup, Mallard, Northern Pintail, Redhead, Ring-necked Duck). Using feather stable-hydrogen values, we derived the origins of harvested birds in a likelihood-based assignment framework and directly compared those to derivations based on direct band returns from the same species. Finally, we integrated band-return data as an informative prior probability of origin to refine harvest derivations. Derivations based on stable isotopes showed some overlap with those based on band returns, but the degree of overlap was variable. Despite this, band returns as a prior probability of origin generally refined harvest derivations. Overall, stable isotopes and band-return data both have their strengths and weaknesses, but together these complementary data can better inform our understanding of harvest connectivity while utilizing existing management frameworks.

Estimating Origins of Greater (Aythya marila) and Lesser (A. affinis) Scaup Wintering Along the Atlantic Coast Using Stable Isotopes and Band Recoveries

Presented by: Brittnie Fleming (brittflemingo@gmail.com)

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Greater (Aythya marila) and Lesser (A. affinis) Scaup have a geographically broad breeding distribution throughout the prairie, boreal, and tundra regions of North America. However, banding efforts of these species is limited and breeding population surveys cover a relatively small proportion of their breeding region, resulting in bias currently unaccounted for in harvest regulations. We estimated proportions of Greater and Lesser Scaup originating or breeding in Quebec and wintering along the Atlantic coast by using stable hydrogen isotope measurements in feathers (δ2Hf; i.e., proportion of deuterium) collected from immature and adult female Greater and Lesser Scaup banded and harvested in the Atlantic flyway, 2019–2021. To predict areas of probable origin, we used a novel technique involving mark-recapture trajectory analysis to weight isotope results longitudinally to areas east or west of Hudson Bay, Canada. To investigate the relationship between region of origin and their non-breeding region, we tested how δ2Hf varied with age (immature or adult) and sampling region in the Atlantic flyway (north, middle, south) to understand if differences in origins of scaup were related to their non-breeding region. Both Greater and Lesser Scaup had greater probability of originating from Quebec than previously reported. For Greater Scaup, 47% estimated to have origins in Quebec and origin did not vary among sampling regions. For Lesser Scaup, individuals sampled from the northern region of the Atlantic flyway originated from further south in their breeding range, and to a greater extent from Quebec (36%) compared to those from the middle (20%) and southern (8%) Atlantic regions. We also found that adults and immature scaup often originated from different areas, suggesting differences in fecundity among breeding areas. Our novel technique could be applied to other waterfowl species to determine if significant breeding areas (i.e., eastern Canada) are unaccounted for in breeding population estimates.

Geographic Origins and Genetics of Banded Mallards in the Northern Atlantic and Mississippi Flyways

Presented by: Kayla Harvey (harvey.kayla_22@yahoo.com)

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Our aim was to refine our understanding of metapopulation dynamics of eastern and Great Lakes population mallards (Anas platyrhynchos) of North America to provide information to useful in population and harvest management. Mallards in the region are increasingly wild × game-farm mallard hybrids because of widespread releases of game-farm mallards. Concurrent with releases, a near 50% decline in eastern mallards in the United States occurred while abundances remained stable in Canada. We used stable isotope (δ2H) and genetic techniques during pre-season banding (July – September) to determine banding location was representative of hatch or molt origin of mallards and if wild mallards captured and banded were of more northern origin. Different from the assumption that pre-season banded mallards are largely of local origin, about 50% of mallards had an origin that was north of their banding site, suggesting substantial fall movements. We detected a similar percentage of hybrid prevalence for the eastern mallard population (~89%), but a substantial increase in the Great Lakes region (~75%) compared to prior studies. However, we did not detect strong evidence for geographic or temporal variation in isotopic values (i.e., origins) of wild and hybrid mallards which suggests that genotypes of mallards occurred together throughout the sampling period. Our results suggest that banding location of mallards in eastern North America does not equate to breeding ground origin nor genotype (wild or hybrid) and recommend investigation of other methods to understand if vital metrics differ among regions and genotypes. Finally, the movement we detected during the banding season could potentially violate important model assumptions that birds do not move among banding units and confound population vital rates estimated using banding returns. We recommend that current integrated population models consider eastern mallards as a single population.

Evaluation of Students' Perceptions of an Online University Course in Waterfowl Ecology and Management

Presented by: Lauren Hernandez-Rubio (lhsenn@g.clemson.edu)

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Online specialized wildlife courses, such as waterfowl ecology and management, and - to the best of our knowledge - online programs such as Clemson University's non-thesis Master's degree in Wildlife and Fisheries Resources, are inaugural curricula in North America and should therefore be evaluated for their effectiveness and success to guide future development of this and other wildlife courses and programs. Dr. Rick Kaminski's Waterfowl Ecology and Management course was converted from traditional face-to-face lecture and laboratory type to online presentation. The course has been offered in fall semesters since 2017. Our objectives were to (1) assess enrolled students' perceptions of and interest in this new online course, (2) determine their views on pedagogical components of the course and their effectiveness in helping them learn and stay engaged with course material, (3) compare respondents' perceptions of the quality and quantity of student interaction and learning experience, and (4) assess respondents' level of experience in various wildlife technical skills and outdoor activities throughout the duration of the course. The course was evaluated each semester by anonymous surveys returned by enrolled students. From 2017-2019, 139 students enrolled and completed the course (86 undergraduate and 54 graduate students). All students in 2017-2019 passed the course, with a total of 87 A's, 41 B's, 10 C's and one D across all years. In the assessment of the online course in waterfowl ecology and management, students indicated that pedagogical components of the waterfowl course maintained similar effectiveness in helping them learn material when compared to both in-person and other online courses. Significant differences observed between graduate and undergraduate responses suggested opportunities to modify current theoretical models in online learning.

The North American Waterfowl Professional Educational Plan for the Next Generation of Waterfowl Conservationists

Presented by: Diane Eggeman (deggeman@ducks.org)

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The North American Waterfowl Management (NAWMP) is a premier example of a successful and enduring plan for ecosystem management and conservation, facilitating recovery and sustainment of waterfowl and wetland wildlife across North America since 1986. We also acknowledge that trained professionals have accomplished these and other natural resource successes since the Migratory Bird Treaty Act (1918). In the early 2000s, concerns arose about a decline in university-based waterfowl programs because of institutional changes in academic curricula and research toward conservation of biodiversity and away from emphases on game species. The 2018 Update of the NAWMP identified the critical need to maintain and expand educational capacity to ensure availability of an appropriately skilled workforce to meet NAWMP conservation goals. In February 2020, the NAWMP Committee endorsed a new initiative termed the North American Waterfowl Professional Education Plan (NAWPEP). The goal of NAWPEP is to engage and assist universities, colleges, and all NAWMP partners with establishing, sustaining, and enhancing academic programs and experiential learning in waterfowl and wetlands science and management to generate skilled waterfowl professionals. Moreover, NAWPEP endeavors to ensure availability of inclusively diverse students and professionals with this expertise from across North America. Results of a NAWPEP survey of private- and public-sector employers of waterfowl professionals suggest that current graduates with waterfowl expertise are adequate for the near term, assuming universities maintain faculty with training foci on waterfowl and wetlands. We believe NAWPEP is a keystone initiative in the wildlife profession focusing on education, research, experience, and extension to conserve waterfowl populations and habitat at a continental scale. We will present a summary of NAWPEP accomplishments including information on supply of graduates from waterfowl

programs, demand for these graduates by employers, waterfowl faculty capacity in 2023 and beyond, and invite insights from attendees of DUCKS9.

An Assessment of the Limitations to Retain Waterfowl and Wetland Trained Graduate Students

Presented by: Chris Nicolai (cnicolai@deltawaterfowl.org)

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Due to concerns regarding training and retaining wildlife conservation professionals, we developed two methods to identify potential individuals to survey based on: 1 – waterfowl advisors providing us a list of their past graduate students, and 2 - a history of being in a waterfowl or wetlands graduate program. The list of respondents provided by professors allowed us to use simple metrics such as gender and whether they entered the wildlife profession to inform if respondents would complete the final survey. We found substantial underrepresentation in our question survey in that students that left the field only responded 8% and 15% of the time for females and males, respectively. Students that remained in the field only filled in the question survey 37% and 46% of the time for females and males, respectively. We identified 4 ways that individuals did not complete the survey which included: 1) we could not find an email address; 2) the found email address bounced, they didn't open the email; or 4) they started, but did not complete the survey. The largest variation across these incompletion rates was explained by the inability to find emails for those that left the field (44%) versus those that remained in the field (14%) which was markedly different for females (16% versus 50% for those the entered the field versus those that left the field, respectively). We developed a 26-question survey with a single linear response variable by using the Likert scale. We modeled all of the 26 questions, and all two-way interactions and used model selection to identify the most important reasons why individuals did not remain in the waterfowl management field. The strongest drivers for entering the wildlife profession was more individual driven for topics such as fitting in, personal inspiration, networking, and meeting long-term goals. Little support was given for passion for hunting or wildlife viewing.

Assessment of Credentials and Experiences for a Successful Career in Waterfowl Science and Conservation

Presented by: Lauren Hernandez-Rubio (lhsenn@g.clemson.edu)

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A paradigm shift in the wildlife profession from a focus on game management to a broader emphasis on biodiversity and conservation has led to a transition in skills important for a successful career in the profession. Traditional emphases, such as wildlife habitat management, quantitative methods, species identification, etc., remain important however, the broadened focus reflects an increase in non-consumptive users and a growing awareness of the importance of human dimensions, inclusivity, and leadership skills in the profession. Identifying credentials and experiences for success in the field of waterfowl science and conservation is of particular importance within the wildlife profession as the number of universities offering waterfowl and wetlands courses has declined. To address this, a survey was conducted in October 2019 of attendees of the 2013, 2016, and 2019 North American Duck Symposium. Our objectives were to determine (1) student academic course-work and experiences (e.g., teaching/research assistantships, internships, mentor programs) professionals deemed important for success in the profession of waterfowl science and conservation, (2) technical skills, professional certification(s), and personal traits considered important for a successful career, and (3) socio-demographic variables and years of professional experience that may further predict credentials for a successful career. Response rate to the questionnaire was 52.7% (364/690). Professionals and students agreed on the importance of traditional technical field and practical skills, such as animal capturing and handling, species identification, wetland classification/delineation, and vehicle/implement operation. They also agreed on the importance of data analysis via statistics and modeling and effective communication of research to peers, sponsors, and the public. Identifying the skills and experiences current waterfowl professionals and students consider important for success will bolster existing and new programs and prepare students for successful careers in this field.

Building Diverse Support for Coastal Wildlife Management Areas to Achieve NAWMP's Third Goal

Presented by: Barbara Avers (aversb@michigan.gov)

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As outdoor recreation trends change, there are consequences to the current funding model and relevancy of wildlife conservation. Coastal wildlife management areas (WMAs) provide a unique case study for understanding diverse stakeholder attitudes, perceptions, and preferences. Using internet and mail-back surveys, we compared waterfowl hunters (n = 316), birdwatchers (n = 1,133), anglers (n = 254), and community members (n = 84) in 2019 at six WMAs in southeastern Michigan, USA. We found differences among stakeholders, especially between waterfowl hunters and birdwatchers, in their attitudes and preferences for wildlife and recreation management, and importance of ecosystem services (ES). However, birdwatchers and waterfowl hunters had important similarities such as importance of several management objectives, increased specialization and commitment to their recreation type, strong recreationist and conservationist identities, and membership in conservation organizations. All groups placed importance on ES, with places for future generations to know and experience nature and places for abundant wildlife, fish, and plants highest in importance. Most agreed that ES were provided by current WMA management, with most agreement for providing public access to nature; abundant wildlife, fish, and plants; and non-consumptive recreation opportunities. Results indicate that birdwatchers are key stakeholders, and the similarities and differences between waterfowl hunters and birdwatchers identify potential conflicts and opportunities for complementary actions that serve a broader set of stakeholders. Building on this common ground and facilitating positive interactions between a diversity of stakeholders may increase financial and political support. ES results inform management decisions so that WMAs are managed to provide ecological benefits to society while still meeting waterfowl, wetland, and waterfowl hunting goals. Communicating connections between quality of life and the ES provided by WMAs may build support for WMAs and help meet NAWMP’s goal to increase and diversify the public that enjoy and actively support waterfowl and wetlands conservation.

Profitability of Farming Wetlands Does Not Meet Farmer Expectations

Presented by: Dustin Toy (dtoy@usgs.gov)

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In addition to being critical to support continental duck populations, many wetlands of the Prairie Pothole Region in North America also provide other ecosystem services to humans. While many of the natural ecosystem services provided by wetlands have been studied, less is known about agricultural services provided by wetlands. We surveyed farmers about their time inputs, yield expectations, and decision factors when cultivating wetlands in their farming operations. We compared those expectations to profits from 19 years and over 4,000 hectares of precision agricultural data from corn and soybean fields in the Drift Prairie in North Dakota. For all types of wetlands and depressional areas, yield and profit from both corn and soybeans declined with increasing wetter weather. Under average weather conditions during early summer, average direct-cost-only profit was 22% less in cultivated portions of temporary wetlands and 34% less in cultivated portions of seasonal wetlands than in upland areas. When the entire wetland area was considered in profit calculations, average crop profit was 48% less in temporary wetlands and 64% less in seasonal wetlands than that of upland areas. Seven of 18 farmers stated that they would continue to cultivate a hypothetical 2-acre wetland despite losing money on that wetland for 10 years. The ability to get machinery into wetlands without getting stuck and keeping the area eligible for prevent plant crop insurance were the primary decision factors for whether a farmer would cultivate a wetland. Conservation efforts could capitalize on the information from this study to develop more mutually beneficial programs for farmers and ducks.

Social Science Integration Across Migratory Bird Joint Ventures

Presented by: Barbara Avers (aversb@michigan.gov)

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The North American Waterfowl Management Plan and Partners in Flight landbird conservation plan include an explicit emphasis on people. Migratory Bird Joint Ventures (JVs) are at various stages of using human dimensions (HD) to increase conservation effectiveness and further the goals of continental bird plans. This assessment documented status and approaches to HD integration among JVs and provided experiential insights. During 2021, we communicated with JV coordinators in a 2-phased approach to determine application and integration of HD in regional bird habitat planning and conservation delivery. All JV coordinators responded. The JV community is keenly aware of the social and environmental change occurring in North America and the importance of using social science expertise to understand humans within JV landscapes. Joint Ventures largely recognized that future conservation focus must include people. However, respondents cited JV traditions and culture, partnership composition, regional landscape characteristics, and staff capacity as major factors limiting ability to manage HD integration. The level of HD engagement by JVs generally fell into one of three groups: 1) no work yet, 2) used available data and literature to improve conservation targeting, develop models, or learn about landowner decision making, and 3) collected HD data with existing staff or through support from outside researchers and used results in conservation decisions. Because JVs were at various stages of conservation planning, some implementation plans lacked an HD emphasis simply because they were outdated. Most JVs viewed conservation social science primarily to serve biological goals, rather than establishing coequal people objectives. Adding social science expertise may be the highest near-term priority for many JVs. Seven of 22 JVs had staff with some formal training in conservation social science.

Implications of Hunting Outfitters in Saskatchewan

Presented by: Matthew Gruntorad (mgruntorad2@unl.edu)

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Non-Canadians who come to Canada for waterfowl hunting opportunity are an important source of conservation funding for many Canadian provinces. Recent changes in some Canadian provinces regarding the requirement to use the services of a certified waterfowl hunting outfitter may impact hunting opportunity and those funding sources. We surveyed individuals who hunted waterfowl in Saskatchewan, within the previous five years, about their use and opinion of outfitters in the province of Saskatchewan. Based on survey responses, we estimated that daily total expenditures by non-Canadian hunters was approximately CAD $1,050. We discovered that of the 745 non-Canadian hunters who participated in our survey, only ~20% used the services of an outfitter during their most recent waterfowl hunting season in Saskatchewan. Of those who did use an outfitter, over 60% revealed outfitter services pertaining to scouting, equipment provision, lack of need to secure hunting permissions, and knowledge of the hunting area were extremely important to their hunt. Nearly 70% of non-Canadian hunters indicated they would not hunt waterfowl in Saskatchewan again if they were required to use the services of an outfitter. Based on our findings, requirements for non-Canadian hunters to use the services of a guide or outfitter would greatly decrease waterfowl hunting participation in Saskatchewan. This decreased participation would then decrease license and stamp sale revenues that may affect provincial programs.

Cessation of Mentors to Waterfowl Hunting

Presented by: Mark Vrtiska (mvrtiska3@unl.edu)

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Due to the steady decline of waterfowl hunters, several studies have investigated means to bolster the waterfowl hunter population. One method of recruiting new waterfowl hunters is through mentoring by existing members of the hunter population. These mentors may serve an important role in the propagation of waterfowl hunting participation and the continued funding of waterfowl conservation. Given the importance of mentors to hunter participation, we sought to discover at what age hunters were most likely to mentor new individuals. Continued participation by individuals (retention) is also critical to bolstering the waterfowl hunter population. Even the most dedicated of waterfowl hunters, including mentors, eventually age to the point where continued participation is no longer feasible. Using the Nebraska electronic licensing database, we also examined the age at which hunters were likely to conclude their participation in waterfowl hunting. Using data from a survey of Central Flyway waterfowl hunters, we found that during the time of the survey, hunters between the ages of 20 and 50 years had a ~0.50 probability of taking someone waterfowl hunting who had never gone before ($\chi 2 = 267.8$, $P < 0.01$). Hunters in their sixties, seventies, and eighties had a 0.29, 0.25, and 0.10 probability of mentoring a new hunter, respectively. We found that Nebraska waterfowl hunters between the ages of 20 and 60 years had ~0.63 probability of purchasing required licensing to hunt waterfowl given they purchased the previous year ($\chi 2 = 779.0$, $P < 0.01$). Hunters in their seventies and eighties had a 0.32 and 0.36 probability of purchasing, respectively. If bolstering of the waterfowl hunter population remains a goal, recruitment programming may wish to consider the promotion of monitoring activity well before the age of 60 years.

Delta's University Hunting Program: Bringing the NA Wildlife Conservation Model to Campus

Presented by: Stephen Sowell (ssowell@deltawaterfowl.org)

J. Brice, Delta Waterfowl

Delta Waterfowl was formed and focuses on waterfowl and wetlands for just one reason: waterfowl hunting. The North American Wildlife Conservation Model threads together people who love and use resources with wise management of those resources. Delta Waterfowl is an example of that principle in action. Waterfowl hunters support our work to identify and implement the best ways to manage and enhance waterfowl populations. In recent decades, it has become imperative that Delta focuses time and resources on the second component of waterfowl hunters. If hunter numbers continue to decline, we fear that management, funding, and advocacy for wetlands and waterfowl will wane without the fire of hunting to stoke interest in those precious resources. Equally alarming, a significant percentage of wildlife students who are future waterfowl management leaders have had neither exposure to hunting, nor first-hand experience of the role of hunting in wildlife management. Students lacking a first-hand understanding of hunting may implement policy and management decisions that do not sustain waterfowl and their required habitats. They simply do not have the full context of the role of consumptive use in the North American model and the impact that the hunting participation decline would have on the ability to manage effectively. Through educational hunting programs, Delta will provide students without a hunting background hands-on participation in the North American Wildlife Conservation model. Delta is advancing a continental program termed the Delta Waterfowl University Hunting Program (UHP). Delta's ambitious goal is to establish a UHP at every North American University that offers a wildlife program. At this time, the target list is approximately 494 universities. Each program includes four components: a hunter education course, a shooting skills day, a waterfowl hunt, and a post-hunt meal. Delta utilizes three participant surveys to measure program effectiveness and drive program improvement. Pre- and post-event surveys provide data to measure program outcomes and outputs. A follow-up survey occurs at the conclusion of hunting seasons to document post-course hunting activity or obtain information on barriers to continued participation. During the fall semester of 2023, Delta delivered 100 UHPs at academic institutions across the US and Canada. Our post event surveys indicated that students had a 96% satisfaction rating and 92% intended to go hunting again after the program.

Optimizing Surveys of Fall-Staging Geese Using Aerial Imagery and Automated Counting

Presented by: Emily Weiser (eweiser@usgs.gov)

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Ocular aerial surveys allow efficient coverage of large areas to monitor wild populations. However, uncertainty around resulting population estimates can be large due to difficulty in visually identifying and counting animals from aircraft and estimating detection probabilities. Photographic aerial surveys can mitigate these challenges and allow flight at higher altitudes, minimizing disturbance of birds and improving safety for surveyors. We evaluated a photographic aerial survey for fall-staging geese at Izembek Lagoon, Alaska, in 2017–2019. Ocular aerial surveys have been completed at Izembek Lagoon for >40 years. For the new photo survey, we used a commercial system to automatically trigger cameras at preset points. We then applied a machine-learning algorithm trained to automatically identify and count geese in our photos, manually corrected those counts, and quantified the algorithm's accuracy. We translated corrected counts into density and extrapolated mean density across the entire lagoon to estimate total population size for Pacific brant (Branta bernicla) and cackling geese (B. hutchinsii). The automated algorithm undercounted geese, but successfully identified the small subset of photos containing geese. Manual correction was therefore needed only for photos automatically identified as containing geese, allowing substantial reduction of workload. Manually-corrected, photo-based population estimates for Pacific brant were considerably larger, and estimates for cackling geese were somewhat larger, than ocular estimates in all 3 years. Photo-based estimates were also generally more precise. Once calibrated against the >40-year timeseries of the ocular survey and associated management thresholds, the photo survey could efficiently guide management of Pacific brant, especially with a new algorithm currently being evaluated for more accurate automated counting. This case study demonstrates how photographic surveys with automated counting can be easily implemented and advantageous to many monitoring programs.

Visibility Correction Factors for Multiple Species of Waterfowl Using an Aerial Remote Sensing Approach

Presented by: Luke Fara (lfara@usgs.gov)

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Aerial ocular surveys are a cost and time-efficient method to evaluate the relative abundance and spatial distributions of waterfowl. However, many ocular survey methods are subject to substantial visibility bias and correction factors must be calculated for incomplete detection. Calculation of visibility correction factors in remote or hard to access places, such as open water environments, is difficult but new technologies offer a means to estimate them. During fall 2021, we used the advanced remote sensing capabilities of the U.S. Fish and Wildlife Service - Division of Migratory Bird Management and Wisconsin Department of Natural Resources ocular survey crew to collect data to estimate visibility correction factors for waterfowl staging on the Wisconsin waters of Green Bay, a sub-basin of Lake Michigan. During two and half flight missions we captured high-resolution digital imagery (e.g., 1-1.5 cm) at 305 meters above ground level in one plane, while a second plane followed along the same transect conducting a blind double observer ocular survey at 61 meters above ground level. Avian targets within the collected imagery will be annotated to the lowest possible taxonomic level (e.g., species) and used to estimate visibility correction factors, along with associated uncertainties at different spatial and temporal scales for multiple species of waterfowl. In addition, annotated imagery will be incorporated with existing databases for training machine learning algorithms that would automate enumeration and classification of targets from remotely sensed data. Estimation of visibility correction factors, leading to more accurate estimates, is important for agencies that are conducting aerial surveys over open water environments to assess waterfowl abundance and distributions during the non-breeding time period.

Remote Sensing for Broad-Scale Population Surveys of Waterfowl: Progress and Challenges

Presented by: Brad Pickens

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Broad-scale population surveys of waterfowl and other migratory birds have traditionally been accomplished by human observers using aircraft flown at low altitude. These methods have proven to be rapid and cost-efficient, however they subject the aircrew to increased risk. In addition, while advanced analytical methods exist to adjust counts for various sources of observer bias, field implementation can be difficult and increases survey cost. Remote sensing increases safety by allowing data collection at higher altitudes and creates a permanent record of observations that offers new opportunities to adjust for detection and classification biases. We have deployed advanced remote sensing systems for USFWS aircraft to support high resolution imaging of waterfowl and other wildlife. These systems generate very large volumes of data during broad-scale surveys that exceed the capacity of natural resources agencies to process manually. Computer vision and machine learning methods are being developed to automate detection and classification of wildlife from imagery. Workflows involving in-flight data processing increase efficiencies. We will review progress and ongoing challenges in development of acquisition technologies, large volume data handling, machine learning processing methods, and use of machine learning outputs in estimation of population size.

An Integrated System of Drones and Artificial Intelligence for Estimating Non-Breeding Waterfowl Abundance

Presented by: Reid Viegut (rav3pt@missouri.edu)

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Biologists currently use a variety of population monitoring methods across waterfowls' non-breeding range, ranging from informal ground counts to low-level aerial surveys. The combination of new technologies, including Unoccupied Aerial Systems (UAS), improved camera sensors, and artificial intelligence, offer the opportunity to develop novel and improved techniques for estimating local waterfowl populations. We have designed an integrated system of UAS and artificial intelligence to estimate waterfowl populations accurately and precisely. This system includes a structured decision-making tool to identify optimal survey methodology and an UAS flight planning app to implement the survey. A graphic user interface then allows users to process imagery and estimate waterfowl abundance in near real-time. To develop this system, we first trained and evaluated several machine learning models using ~300,000 bird labels from thousands of aerial images. We also evaluated the impacts of availability and perception bias on waterfowl count estimates derived from artificial intelligence processing of aerial imagery 15 - 60 meters in height (0.342 to 1.52 cm/pixel). Vegetation cover type and survey height were the major factors influencing waterfowl availability and detection in UAS surveys, and using well-trained machine learning algorithms may produce counts with 85% or greater accuracy per image under a variety of survey conditions. Detection probabilities were then incorporated into simulations of UAS waterfowl abundance surveys to evaluate the effects of survey design on accuracy and precision of waterfowl abundance estimates. In addition, we evaluated the behavioral responses of waterfowl

to UAS surveys and found UAS flights did not influence waterfowl behavior regardless of survey parameters and environmental conditions. Results demonstrate that our integrated system of UAS and artificial intelligence is an efficient and accurate approach for estimating waterfowl abundance on non-breeding areas.

Progress Toward Automated Migratory Waterfowl Census Using Drones and Deep Learning

Presented by: Rowan Converse (rowanconverse@unm.edu)

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Wildlife managers invest substantial resources in monitoring populations of migratory waterfowl. Aerial imaging surveys appear to yield more precise counts compared with traditional ground and aerial survey methods; however, given the substantial time investment required to manually interpret aerial imagery of wildlife, automated image interpretation methods, such as deep learning, will be needed to make this approach scalable. We present current progress, continuing problems, and lessons learned from a cooperative research project with the US Fish and Wildlife Service to develop an unoccupied aerial system (UAS) field survey workflow for censusing wintering waterfowl at federally managed wildlife refuges in New Mexico as well as a deployable convolutional neural network (CNN) model for automated detection and classification of waterfowl. The goal of this research program is to develop a scalable workflow that can be deployed at wildlife refuges within the federal system throughout the United States and beyond. Our framework utilizes crowdsourced UAS image annotations from the participatory science platform Zooniverse; we validated these annotations against annotations from wildlife biologists and found that the consensus of the two groups was comparable in enumerating (91%), classifying to general taxonomic group (99.99%), and locating (80%) birds in the imagery. We tested multiple CNN architectures and selected YOLOv5 for its performance. Models trained on the crowdsourced annotations outperform the more limited expert annotations, even when subsampled to the same number of annotations as the expert set; thus, in terms of field planning for collecting training images at novel sites, our results indicate that suitable training data may be expeditiously collected with as little as a single UAS transect per site (~10-15 images), focusing on collecting representative variability (i.e., of species, vegetation, environmental conditions, etc.). We will present future directions including a planned 2023 winter field deployment to test the census workflow at sites in New Mexico and Texas.

Evaluation of Traditional Aircraft and UAV Survey Methodologies to Assess Wintering Waterfowl Populations

Presented by: Stephanie Braswell (szb0208@auburn.edu)

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Suitably designed population surveys produce defensible estimates and account for methodological biases using probability-based sampling approaches. Although waterfowl populations have been surveyed for nearly a century, obtaining estimates of precision and accounting for observer biases remains a challenge in many situations. We are working with the Alabama Wildlife and Freshwater Fisheries Division (AWFF) to evaluate and examine options for increasing robustness of their wintering waterfowl population estimates on public lands of the Tennessee River Valley of north Alabama and in the coast, bay, and Delta areas of Mobile, Alabama. During November-February 2021-2024, we are analyzing and implementing double-observer methods, distance sampling, repeated surveys, and observer variability trials into pre-existing crewed aerial surveys as well as unmanned aerial vehicle (UAV) surveys. Additionally, we are initiating near-synchronous, supplementary UAV surveys into AWFF's historic crewed aerial surveys. From analyses, we have observed low UAV imagery observer variability with ~70% of images having a coefficient of variation <10% among total counts by replicate observers. Detectability in crewed aircraft surveys has increased from 66.2% using a single-observer to 92.2% using double-observer methods with observer analysis showing slight variability potentially due to experience differences. Near-synchronous survey analyses are consistent with expected outcomes showing non-detections of low-abundance species and count biases. As is likely in other areas where non-breeding waterfowl congregate, a major challenge in our study areas is extremely high spatial-temporal variability in waterfowl abundance at spatial scales amenable to UAV surveys, with total waterfowl counts on individual drone polygons ranging from 0 to 7500. Collectively, this work is intended to give AWFF and other entities flexible options for producing defensible population estimates with explicit measures of precision.

UAV-Based Waterfowl Detection Using Deep Neural Networks

Presented by: Zack Loken (zackloken@gmail.com)

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Understanding how waterfowl respond to habitat restoration and management activities is crucial for evaluating and refining conservation delivery programs. However, site-specific waterfowl monitoring is challenging, especially in heavily forested systems such as the Mississippi Alluvial Valley (MAV)—a primary wintering region for ducks in North America. We hypothesized that using uncrewed aerial vehicles (UAVs) coupled with deep learning-based methods for object detection would provide an efficient and effective means for surveying non-breeding waterfowl on difficult-to-access restored wetland sites. Accordingly, during the winters of 2021 and 2022, we surveyed wetland restoration easements in the MAV using a UAV equipped with a dual thermal-visible high-resolution sensor to collect 2,360 optical images of non-breeding waterfowl. We then developed, optimized, and trained a SingleShot MultiBox Detection (SSD) object detection model with a deep convolutional neural network (VGG16) backbone to locate and identify eight different duck species in the UAV imagery. The final model achieved a total mean average precision and recall of 99.1% and 82.9%, respectively, after only 60 training epochs. The individual species class precision ranged from 65.3 to 86.1%, while the species class recall ranged from 69.7 to 88.6%. This study demonstrates the promise of UAV-based surveys for effectively surveying non-breeding waterfowl in structurally complex and difficult-to-access habitats and, additionally, provides a functional deep learning-based object detection framework for automated detection of non-breeding waterfowl in UAV imagery. This framework can be used to provide managers with an efficient and cost-effective means to count waterfowl on project sites—thereby improving their capacity to evaluate waterfowl response to wetland restoration efforts.

Uncrewed Aerial Systems Provide a Valuable Tool for Assessing Duck Production at Local Scales

Presented by: Amanda Griswold (agriswol@uwsp.edu)

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The primary goal of waterfowl conservation is to provide long-term protection for waterfowl by implementing strategies to maintain or increase their populations. Recruitment of new individuals into the population offsets mortality and is an important component of population dynamics. Among upland nesting duck species, the survival of potential recruits is largely dependent on habitat conditions. Identifying quality breeding habitat that promotes nest success, duckling survival, and ultimately recruitment is critical for effective waterfowl conservation. To that end, biologists in Wisconsin recently developed a decision support tool that guides waterfowl habitat restoration and retention efforts in Wisconsin by ranking watersheds for conservation priority. The tool uses biological data to predict where resources exist for waterfowl, particularly breeding habitat for mallards, wood ducks, blue-winged teal, and ring-necked ducks, but it has not been formally validated. We used uncrewed aerial systems with thermal imaging to collect observations of breeding pairs and broods at 22 sites across a range of conservation priority rankings in Wisconsin during 2022 and 2023 to examine the Wisconsin decision support tool. We also examined potential drivers of variation in pair and brood densities at wetlands in Wisconsin and examined the relationships between breeding pair and brood densities. Our results suggest that the Wisconsin decision support tool provides an accurate assessment of local habitat quality for breeding waterfowl. Further, our results indicate that breeding pair density is correlated with brood density, and both are affected by local habitat conditions. Uncrewed aerial systems equipped with thermal capabilities allowed us to achieve productivity estimates in an efficient and non-invasive manner. These systems can be an asset to wildlife conservation and should be considered as an alternative method to study waterfowl populations.

AIMS for Wildlife: Developing an Automated Interactive Monitoring System for True Adaptive Management

Presented by: Mike Casazza (mike_casazza@usgs.gov)

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To effectively manage species and habitats at multiple scales, population and land managers require rapid information on wildlife use of managed areas and responses to landscape conditions and management actions. GPS tracking studies of wildlife are particularly informative to species ecology, habitat use, and conservation. Combining GPS data with administrative data and a diverse suite of remotely sensed, geo-referenced mental (e.g., climatic) data, would more comprehensively inform how animals interact with and utilize habitats and ecosystems and our goal was to create a conceptual model for a system that would accomplish this – the 'Automated Interactive Monitoring System (AIMS) for Wildlife'. Our objective for this study was to build a "proof of concept" system based on our 8-year GPS tracking dataset of ~11 million locations from 1338 individual (16 species) avifauna and make actionable, real-time data on animal movements and trends available to managers and stakeholders for rapid application in day-to-day management. The AIMS ecosystem consists of three primary components: 1) data ingestion 2) data processing and storage and 3) product delivery. Outputs can be easily customized into customized wildlife reports (CWR'S), web applications, wildlife alerts and basic data summaries emphasizing the broad application of an animal movement data source. Utilizing diverse, extensive telemetry data streams through scientific collaboration can aid managers and conservation stakeholders with short and long-term research and conservation planning and help address a cadre of issues from local-scale habitat management to improving the understanding of landscape level impacts like drought, wildfire, and climate change on wildlife populations.

Lucky Ducks: North American Waterfowl Hold Secrets of Successful Conservation Strategies

Presented by: Fiona McDuie (fmcduie@usgs.gov)

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Three billion birds have been lost across North America in the past fifty years. Only three taxa have not declined, one is waterfowl. This group has been the subject of multi-scale, continent-wide conservation efforts, legislation, and management for approximately 150 years and beneficiaries of global conservation actions and policies. We examined the long-term efficacy of these actions by interrogating a very large waterfowl dataset to evaluate habitat selection and land use by 14 species of ducks and geese over 6 years. We demonstrate the importance of protected wetland habitats and agricultural lands that employ waterfowl beneficial land-use practices. These essential habitats have been conserved through private duck clubs, the federal National Wildlife Refuge (NWR) system and an extensive farmer participation federal habitat protection program, the Conservation Reserve Program (CRP). The effective approach, backed by local Joint Ventures, is supported by national and international legislations such as the North American Waterfowl Management Plan (NAWMP), the Migratory Bird Treaty and North American Waterfowl Conservation Act (NAWCA), all of which contribute to protection and conservation of waterfowl and their critical habitats. Ultimately, waterfowl conservation success demonstrates the advantages of extensive cooperation among diverse public and private stakeholders, and of employing a synergistic approach that combines local, national and international conservation legislations.

Spatiotemporal Variation in Space-Use of Mallards and Northern Pintails Wintering in Southwest Louisiana

Presented by: Katharine Goodenough (kgoodenough@agcenter.lsu.edu)

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Overwintering is a critical annual life history event for waterfowl where individuals recover lost nutrients from prior annual events (e.g., fall migration, molting) and prepare for energetically costly upcoming events (e.g., spring migration, reproduction). As a game species, migratory waterfowl additionally face harvest pressure during the overwintering period and this landscape pressure influences movement and behavior. Previous research in southwest Louisiana from the 1990s provided evidence for the refuging theory which posits that individuals concentrated within a central place will increase distance traveled over time as easily accessed food resources in closer proximity to refugia will be depleted. We used hourly GPS/GSM satellite marked northern pintails (Anas acuta; n = 68) and mallards (Anas platyrhynchos; n = 12) captured on public refuges to further evaluate temporal and spatial changes in overwintering space-use and daily foraging distance within southwest Louisiana during the 2021-22 and 2022-23 wintering period. We used continuous time movement modeling to develop autocorrelated kernel density space-use estimations at three-day intervals throughout the overwintering period to compare differences in space-use during time periods prior to hunting, during hunting, and after hunting seasons. We additionally calculated daily net squared displacement for morning and evening foraging flights. Preliminary results support prior research indicating larger space-use for northern pintail compared to mallards. However, considerable variation in three-day space-use size exists among individuals within both species across periods of open and closed hunting seasons. Future analyses will consider how temporal use or non-use of refugia may influence observed heterogeneity in space-use and daily foraging distance. An improved understanding of fine-scale wintering movements and behavior from individuals interfacing between publicly managed refuge and privately hunting landscapes may facilitate insights regarding how and where refugia habitat occur across the landscape.

Leveraging Telemetry Data to Understand Avian Influenza Ecology in Wild Birds

Presented by: Diann Prosser (dprosser@usgs.gov)

D.J. Prosser, USGS Eastern Ecological Science Center

Avian influenza viruses pose a notable threat to wildlife and livestock health at local, national, and global scales. While previous studies have demonstrated that wild waterfowl play an important role in the spread and persistence of AIVs, there has historically been little done to understand how infection with HPAI impacts individual birds in the wild and the implications of such impacts on transmission dynamics. This presentation will describe numerous ongoing efforts to leverage telemetry datasets, often collected initially for waterfowl ecology studies, to help understand various factors related to avian influenza transmission, persistence, and impacts on wild birds. Results presented will include studies exploring species specific impacts of HPAI infection on Lesser Scaup, Lesser Snow Goose, and Mallards; all of which were detected solely through pairing disease sampling with ongoing tracking efforts. Additionally, this talk will explore efforts to integrate telemetry data in SIR models, agent-based models, and global networking models to understand how infections can spread between individuals, locations, flyways, and even continents. Finally, we will discuss the use of telemetry data to explore relationships between domestic poultry production sites and what factors may increase the likelihood of both overlap at the wild-domestic bird interface as well as transmission events. The overarching goal of this talk will be to express the variety of ways in which disease sampling can be paired with ongoing research efforts to add value to the extensive efforts already taking place.

Not All Sanctuaries Are Created Equal: Variation in Protected Area Selection by Wintering Mallards

Presented by: Ethan Dittmer (dittmerethan@gmail.com)

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Public lands managed for wildlife frequently provide various forms of designated sanctuary to increase residency times and allow access to energetic and other habitat resources for waterfowl. However, the influence of sanctuary type and disturbance regime on resource use and fine-scale movements of waterfowl has not been investigated extensively using currently available transmitter technologies. We examined mallard (Anas platyrhynchos) use of various types of designated waterfowl sanctuary and non-sanctuary areas in the Mississippi Alluvial Valley region of eastern Arkansas, USA during the winters of 2019, 2020, and 2021. We deployed 105 GPS transmitters on mallards at four closed-access spatial sanctuaries on or adjacent to Dale Bumpers White River National Wildlife Refuge. We used hourly transmitter locations to examine mallard use of public sanctuary areas, public hunt areas, and private lands using Integrated Step Selection Analysis. Public sanctuary areas provided varying levels of protected status, public hunt areas allowed for varying levels of hunting intensity by duck hunters, and private lands were privately owned areas but may or may not have been hunted at any specific frequency. Mallards selected for spatial sanctuary and avoided public hunt areas, other sanctuary types, and private lands during the day. In contrast, mallards selected for private lands over spatial sanctuary nocturnally. Mallards largely avoided areas that allowed duck hunting or selectively used them during the night when the risk of harvest mortality was removed. Shortly after the hunting season closed, mallards began using areas that previously allowed duck hunting during the day, suggesting that risk was the primary factor influencing site use. Moreover, mallards were 1.6 times more likely to use public daily hunt areas and 2.1 times more likely to use private lands potentially open to hunting during the day than spatial sanctuary two weeks after the close of duck hunting season in February.

Effects of Landscape Patterns on Northern Pintail Movement and Energetics During Late Winter

Presented by: Georgina Eccles (georgina_roxanne.eccles@students.tamuk.edu)

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Non-breeding ecology of northern pintail remains understudied and a better understanding of the species' movements and energetics could help inform future management decisions. The aim of this study was to identify the spatial drivers of movement and energy expenditure in female northern pintails during late winter. Our objectives were to (1) investigate how landscape configuration influenced movement rates prior to spring migration departure and (2) determine the spatial compositions that govern how energy is expended across the landscape. Females were captured within six wintering regions (Central Valley of California, Southwestern Arizona, Central and Eastern New Mexico, Texas Panhandle, Texas Coast, and Louisiana Coast) and fitted with Ornitela GPS/GSM backpack style devices. Using GPS data, we delineated winter and spring periods with movement classification outputs from our Hidden Markov Models. We calculated daily home ranges for each female using minimum convex polygons (MCP). Daily step lengths (km) were calculated using successive GPS locations. Accelerometer-derived Overall Dynamic Body Acceleration (ODBA, a proxy for energy expenditure) was calculated and average daily ODBA recorded. Land-cover data was clipped within MCPs and landscape composition and configuration metrics were calculated including percent land cover, Euclidean nearest neighbor and interspersion and juxtaposition. We implemented two Generalized Linear Mixed Models (GLMM) predicting landscape composition and configuration metrics on (1) daily ODBA and (2) daily step lengths. Our findings will reveal landscape drivers of energy

expenditure prior to spring migration. We anticipate these findings will help habitat managers in making informed decisions regarding the spatial placement and provisions of habitats for wintering waterfowl.

Transmitter Effects on Spring Migratory Step-Lengths and Latitudinal Positioning of Winter-Marked Female Mallards

Presented by: Douglas Osborne (osborne@uamont.edu)

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Tracking devices are being used for investigating movement ecology of waterfowl. While advances in transmitter technology have made fine-scale movement data much more accessible, the potential effects of transmitters on movement and behaviour have regularly been ignored. We fitted mallards (Anas platyrhynchos) with backpack transmitters using two harness attachment methods and abdominally implanted transmitters. While backpacks have greater potential to influence aerodynamics and restrict movements, they can be readily attached in the field by trained biologists and can record more frequent data due to solar charging. Conversely, abdominal implants likely have limited effects on aerodynamics but require intensive surgery by licensed veterinarians and have a shorter functional capacity. We aimed to compare step length and migration latitude of female mallards among transmitter types to inform the utility of and advance toward the standardization of methodologies used to understand avian movement. We deployed 96 transmitters (n=36 backpack with single-loop harness, n=36 backpack with double-loop harness, and 24 implantable devices) across four sites in Arkansas and Missouri during February 2023. We calculated mean step length using integrated step selection functions and mean latitude of female mallards by transmitter type by month between February-June 2023. Overall, mean step length was greater for implants (x=2,277 m; SE=1,514 m), relative to single loop (x=1,393 m; SE=1,091 m), and double loop backpacks (x=1,216 m; SE=747 m). Likewise, implants were located at higher latitudes ($\bar{x}$ april = 45.2 ± 2.8) during migration on average compared to single-loop ($\bar{x}$ april = 42.9 ± 3.4) and double-loop ($\bar{x}$ april = 43.0 ± 3.6) harness backpacks. A clear understanding of the effects of different transmitter attachment methods on free-ranging mallards is necessary to ensure information gleaned from these data are representative of the populations from which we wish to draw conclusions.

A Closer Look at Staging Areas: Linking Atlantic Brant Behaviour with Habitat Type in James Bay

Presented by: Lindsay Carlson (lindsay.carlson@usask.ca)

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James Bay is a shallow, river-influenced extension of the Hudson Bay and a critical stopover region for Atlantic Brant during fall and spring migration. However, the coastal ecosystem has been negatively affected by climate change and hydroelectric development. Over the past 30 years, dense eelgrass extent declined 40%, and Cree land users have reported a marked decrease in brant using the eastern coast. The objective of our work is to characterize brant behaviour and habitat use in James Bay to better understand within-staging area decision-making, energetic expenditure, and nutrient acquisition. We deployed 250 Global Positioning System/tri-axial acceleration (GPS-ACC) transmitters on Atlantic brant during 2018-2023. We programmed the transmitters to collect an ACC burst every 6 minutes and assigned a behavioural class (e.g., feeding, stationary, flying) to data from 110 completed migrations. Of these, 72 individuals used portions of both coasts, five individuals used only the eastern James Bay coast, and 33 individuals used only the western coast.Use of eastern James Bay was concentrated on the south coast (61% of locations), primarily during spring. The mudflat-saltmarsh interface was most used; the proportion of time feeding in this habitat was 96% in spring and 83% in fall. Limited eelgrass exists in this region (Boatswain Bay) compared to the northeast coast, but only 1.1% and 2.8% of feeding/swimming behaviours occurred on known eelgrass beds during spring and fall, respectively. Use of western James Bay was concentrated around Akimiski Island (28% of locations), with similar use in both spring and fall. The mudflat-intertidal marsh interface was most used; the proportion of time feeding in this habitat was 94% in spring and 93% in fall. Our findings suggest that brant may have adapted to reduced eelgrass availability by using

alternate habitats, and further work will explore energetic and reproductive consequences of these staging choices.

Altitude Selection in Migrating Geese Produces a High Risk of Collision with Offshore Wind Turbines

Presented by: Emily Weiser (eweiser@usgs.gov)

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Renewable energy facilities are a key part of mitigating climate change, but can pose threats to wild birds, most often through collisions with infrastructure. Understanding collision risk and the factors affecting it can help minimize the risk to wild populations. We quantified altitude selection of Pacific Flyway geese on transoceanic migrations between Alaska and the Pacific Coast of the contiguous U.S., an area where offshore windfarm development is beginning. We tracked the location and altitude of 45 geese of three subspecies (Pacific greater white fronted goose, tule greater white fronted goose, and lesser snow goose) >1 km from the coast across 114 migration bouts during spring and fall. We evaluated how geographic and environmental covariates affected 1) whether birds were at rest on the water vs. in flight and 2) altitude selection. We used the model results to predict how often geese would be within a potential rotor-swept zone (20–200 m asl) under various conditions. Further application of this formal altitude-selection framework to other species would be useful to understand how windfarms in this area may affect the migratory bird community.

Validating eBird Using GPS Telemetry to Inform Waterfowl Responses to Extreme Weather Event

Presented by: Orin Robinson (orinjrobinsonjr1@gmail.com)

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Global climate change is increasing the frequency and severity of extreme climatic events (ECEs) which may be especially detrimental during late-winter when many species are surviving on scarce resources. However, monitoring animal populations relative to ECEs is logistically challenging. Crowd-sourced datasets may provide opportunity to monitor species' responses to short-term chance phenomena such as ECEs. We used 14 years of eBird—a global citizen science initiative—to examine distribution changes for seven wintering waterfowl species across North America in response to recent extreme winter polar vortex disruptions. To validate inferences from eBird, we compared eBird distribution changes against locational data from 362 GPS-tagged Mallards (Anas platyrhynchos) in the Mississippi Flyway. Distributional shifts between eBird and GPS-tagged Mallards were similar following an ECE in February 2021. In general, the ECE affected continental waterfowl population distributions; however, responses were variable across species and flyways. Waterfowl distributions tended to stay near wintering latitudes or moved north at lesser distances compared with non-ECE years, suggesting preparedness for spring migration was a stronger “pull” than extreme weather was a “push” pressure. Surprisingly, larger-bodied waterfowl with grubbing foraging strategies (i.e., geese) delayed their northward range shift during ECE years, whereas smaller-bodied ducks were less affected. Lastly, wetland obligate species shifted southward during ECE years. Collectively, these results suggest specialized foraging strategies likely related to resource limitations, but not body size, necessitate movement from extreme late-winter weather in waterfowl. Our results demonstrate eBird's potential to monitor population-level effects of weather events, especially severe ECEs. eBird and other crowd-sourced datasets can be valuable to identify species which are adaptable or vulnerable to ECEs and thus, begin to inform

conservation policy and management to combat negative effects of global climate change.

Incorporating Dynamic Processes into Conservation Planning Tools

Presented by: Kaylan Kemink (kkemink@ducks.org)

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Traditional approaches for including species' distributions in conservation planning have presented them as long-term averages of variation. Like these approaches, the main waterfowl conservation targeting tool in the United States Prairie Pothole Region (US Prairie Pothole Region) is based primarily on long-term averaged distributions of breeding pairs. While this tool has supported valuable conservation, it does not explicitly consider spatiotemporal changes in spring wetland availability and does not assess wetland availability during the brood rearing period. We sought to develop a modelling approach and targeting tool that incorporated these types of dynamics for breeding waterfowl and broods. This goal also presented an opportunity to compare predictions from a traditional targeting tool based on long-term averages to predictions from spatiotemporal models. Such a comparison facilitated tests of the underlying assumption that the traditional targeting tool could provide an effective surrogate measure for conservation objectives such as brood abundance and climate refugia. We developed spatiotemporal models of breeding waterfowl and brood abundance within the US Prairie Pothole Region. We compared the distributions predicted by these models and assessed similarity with the averaged pair data that is used to develop the current waterfowl targeting tool. Results demonstrated low similarity and correlation between the averaged pair data and spatiotemporal breeding waterfowl and brood models. The spatiotemporal breeding waterfowl model distributions served as better surrogates for brood abundance than the averaged pair data. Our study underscored the contributions that the current targeting tool has made to waterfowl conservation but also suggested that conservation plans in the region would benefit from the consideration of inter- and intra-annual dynamics. We suggest that using only the averaged pair data and derived products might result in the omission of 46%–98% of important breeding waterfowl and brood habitat, respectively, from conservation plans.

Developing a Decision Support Tool for American Black Duck Conservation During the Non-Breeding Period

Presented by: John Coluccy (jcoluccy@ducks.org)

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Habitat protection and restoration efforts for American black ducks across the non-breeding range is largely opportunistic and lacks scientific underpinnings. To understand black duck wetland habitat requirements during the non-breeding period and focus conservation delivery, we developed the American Black Duck Decision Support Tool (DST). We built a bioenergetics model to compare estimates of energy demand placed on wetland habitats by dabbling ducks with estimates of energy supply provided by wetlands during the non-breeding period at the HUC12 scale across the US portion of the Atlantic and Mississippi Flyways and southern eastern Canada (BCRs 12, 13 & 14). Energy supply estimates were derived from replicated field studies that measured energy density by wetland type. These estimates were then related to National Wetland Inventory features by relating the energy density by wetland type to the associated NWI Cowardin wetland codes. Estimates of energy demand were derived by stepping down North American Waterfowl Management Plan 80th percentile population goals for nine dabbling duck species and applying estimates of daily energetic need and migration chronology to calculate population level energy demand for the non-breeding period. We calculated habitat protection and restoration objectives for each HUC12 watershed and prioritized watersheds based on protection and restoration objectives and their relative energetic importance to black ducks. We developed a public-facing web application using ArcGIS Experience Builder. This web application includes three interactive maps of HUC12 watersheds that are symbolized to show conservation priorities for black ducks, restoration and protection objectives for all dabbling ducks, and relevant model inputs. Users can download individual map layers and all supporting data. This tool establishes biologically based wetland restoration and protection objectives and identifies small scale watersheds to focus conservation efforts for improving conditions for black ducks and other dabbling ducks.

Strategic Habitat Conservation Drives Conservation Delivery for Prairie-Breeding Waterfowl

Presented by: Heath Hagy (heath_hagy@fws.gov)

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Waterfowl represent one of the most widely prioritized resources of concern on public and private lands managed for wildlife across the United States (US). The Prairie Pothole Region (PPR) is one of the most unique wetland-grassland systems on the planet and produces a large portion of the continental population of ducks in some years. The U.S. Fish and Wildlife Service's Habitat and Population Evaluation Team (HAPET) was originally established to support waterfowl conservation in the Prairie Pothole Joint Venture (PPJV) but also has produced a large number of products to optimize conservation delivery and increase the effectiveness and efficiency of conservation efforts supporting partner projects on a wide variety of grassland-nesting birds (e.g., ducks, shorebirds, upland gamebirds). HAPET has adopted a modular "tool box" approach to conservation planning, where foundational models and decision-support tools can easily be modified to best meet the needs of specific situations, whether at local, regional, national, or international scales. For example, HAPET'S mechanistic model of grassland conversion uses a suite of economic and environmental predictors to spatially estimate grassland loss across the contiguous United States. This model can help ensure efficient and effective use of limited conservation funds by incorporating risk of grassland conversion in conservation planning efforts. We will present several tools ranging from predicted wetland availability under projected climate scenarios to grassland conversion risk models that can optimize partner-based habitat conservation efforts in the PPR for waterfowl and other grassland-nesting birds under a strategic habitat conservation regime.

Evaluating Conservation Units at the Continental Scale Using Network Analysis: A Sea Duck Case Study

Presented by: Juliet Lamb (juliet.lamb@tnc.org)

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Conserving migratory wildlife requires understanding how groups of individuals interact across seasons and landscapes. Telemetry reveals individual movements at large spatiotemporal scales; however, using movement data to define conservation units requires scaling up from individual movements to species-and community-level patterns. We developed a framework to define flyways and identify important sites from telemetry data and applied it to long-term, range-wide tracking data from three species (640 individuals) of North American scoters (Melanitta spp.). Our network of 88 nodes included both multi-species hotspots and areas uniquely important to individual species. We found limited spatial overlap between scoters wintering on the Atlantic and Pacific coasts of North America, with differing connectivity patterns between species. Black scoters from Eastern and Western wintering sites did not overlap; however, surf and white-winged scoters overlapped across a limited range of breeding sites, which showed high levels of importance for population connectivity in the multi-species network. We also used the network model to identify four distinct multi-species conservation units based on individual movements, which did not correspond to traditional management flyways. While Eastern scoters showed similar connectivity

patterns and migration routes across all species, migratory routes were less uniform for Western scoter populations and groups of interconnected sites differed among species. Overall, we show how individual movements can be used to quantify connectivity of migratory species at range-wide scales and identify potential gaps in landscape-level conservation strategies.

SWAMP: Updates on an Agent-Based Model of Winter Foraging and Energetics

Presented by: Rob Blenk (rb366@humboldt.edu)

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The Spatially-explicit Waterbird Agent-based Modeling Program (SWAMP) is an individual-based, spatially-explicit model of winter waterfowl foraging, behavior, and energetics designed to provide decision support for conservation stakeholders. SWAMP estimates the energetic carrying capacity of landscapes by using input parameters on available food energy, waterfowl populations, migration, and behavior to simulate a population of waterfowl over a winter season. Outputs from the model include several metrics of interest such as survival and mortality rates, energetic reserves of birds, spatial distribution and habitat use, and time activity budgets of simulated individuals. In the model's most recent implementation, we assess the carrying capacity of California's Suisun Marsh, a region of critical importance for wintering waterfowl. Using newly-generated estimates of landscape food availability from concurrent field efforts, along with empirically derived estimates of foraging efficiency from captive foraging studies, we simulate dabbling duck populations commensurate with Joint Venture goals to assess the survival and lipid reserves of ducks utilizing the marsh. Model outputs suggest that Suisun Marsh, at current levels of food production, is unlikely to support Joint Venture goal populations; simulations of duck populations at goal levels resulted in high degrees of mortality and emigration from the system (sometimes exceeding 40%). These simulations suggest that a re-evaluation of Suisun Marsh waterfowl population goals is needed to better reflect the updated estimates of food production and the region's energetic carrying capacity. More generally, our analysis illustrates the added value of an individual-based model and we discuss new directions that such an approach may enable to provide expanded decision support for wetland and waterfowl managers.

Informing Waterfowl Conservation Planning with an Agent-Based Model: Quantifying Mallard Response to Wetland Composition and Configuration

Presented by: Lisa Webb (webbli@missouri.edu)

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The Natural Resources Conservation Service administers Wetlands Reserve Easements through the Agricultural Conservation Easement Program, formerly the Wetland Reserve Program, to assist landowners in conserving and improving wetland ecosystems on private land. These wetland easements constitute an important foraging resource for waterfowl, however their management for the benefit of waterfowl populations depends on understanding waterfowl responses to habitat conditions, which may be based on complex and emergent interactions between behavioral, environmental and anthropogenic factors. We used an agent-based model (ABM) to evaluate conservation planning strategies related to the acquisition of new easements, with the aim of maximizing benefits for wintering waterfowl populations. To model mallards wintering in the Mississippi Alluvial Valley, we adapted an existing energetics-based ABM that allows for tracking the physiological and behavioral response of mallards to dynamic habitat conditions and emergent behaviors of populations at the landscape scale. We then developed a suite of conservation scenarios focusing on current and potential easement amounts and configurations, including increasing easement area by 25%, either through adding new easements or rounding out existing easements at opportunistic or selected locations. Model results indicate removing existing conservation measures would reduce wintering mallard population size by ~70-80% in the study area, emphasizing the important role current wetland easements play in wintering waterfowl conservation. Increasing easement area through the addition of new easements was more effective than adding area to existing easements and increased mallard populations 10-16% over baseline conditions. Adding fewer, larger area easements generally increased mallard populations more than adding smaller, more numerous easements.

Conservation Planning for Western Gulf Coast Mottled Ducks

Presented by: Joe Lancaster (jlancaster@ducks.org)

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The mottled duck (Anas fulvigula) is a resident waterfowl species found in Florida, the south Atlantic Coast of South Carolina and Georgia, and the western Gulf Coast (WGC) portions of Alabama, Mississippi, Louisiana, Texas, and northeast Mexico. WGC mottled ducks meet all life cycle requirements from their year-round home of Gulf Coast marshes and associated habitats, and their U.S. range is nearly coincident with the geographic boundary of the Gulf Coast Joint Venture (GCJV). The GCJV is a bird conservation partnership situated in one of the priority habitat regions of the North American Waterfowl Management Plan. Due to concerns about the population status of WGC mottled ducks, the GCJV Management Board initiated a Mottled Duck Working Group in 2003 to provide mottled duck conservation guidance to GCJV partners. The ensuing Mottled Duck Conservation Plan (Wilson 2007) established a population objective and identified the highest priorities to improve mottled duck populations through habitat conservation, adaptive management, and research needs to refine our understanding of population limiting factors for the species. Over the next decade, the Conservation Plan guided research, conservation delivery programs, creation of decision support tools, and development of new monitoring protocols. As part of the iterative framework of adaptive management, the Working Group reconvened in 2016 to review contemporary scientific information, revise conservation strategies and research needs, and produce a Conservation Plan Update to guide the next several years of mottled duck conservation. This presentation will discuss the successful use of the adaptive management process to refine conservation planning for WGC mottled ducks over the past two decades and current status of WGC mottled duck conservation.

Incorporating Wetland Complex Characteristics to Improve Conservation Planning for Waterfowl and Hunters in the Lower Mississippi Valley

Presented by: Anne Mini (amini@abcbirds.org)

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Conservation planning for non-breeding waterfowl often uses energy-based modeling to determine how well the landscape supports waterfowl populations. The Lower Mississippi Valley Joint Venture (LMVJV) uses a bioenergetics model in its conservation planning to measure progress towards North American Waterfowl Management Plan goals. However, the LMVJV recognizes that waterfowl respond not just to energy, but to a wide variety of landscape conditions and characteristics. Accordingly, the LMVJV developed a spatially-explicit wetland suitability model to predict quality (e.g., predicted waterfowl use) in relation to energy, sanctuary, and juxtaposition of wetland types. Our model included minimum extent of surface water coverage, proximity to wetland types extensively used by waterfowl (e.g., emergent, forest, deep open water, and cropped wetland), and designated sanctuary within the approximate home range of a mallard (3.5 km). Using focal statistics in ArcGIS, we calculated the percentage of each wetland type within a 3.5 km radius around any individual pixel. We developed a wetland suitability index to rank these percentages from 0 (unsuitable) – 1 (highest quality) and used weighting factors for each wetland type to adjust relative quality. We combined the resulting data layers from each wetland type and added a sanctuary layer to produce the final wetland complex map. The resulting map tool identified key areas of importance for prioritizing future conservation efforts and, conversely, showed significant areas that lacked optimal levels of one or more resource types and would be less likely to be used by waterfowl. This product allows exploration of how areas could be improved to provide better conditions for waterfowl, and how important waterfowl areas may benefit other wetland-dependent species.

Human Access Constrains Optimal Foraging and Habitat Availability of Mallards in an Agriculturally-Dominated Landscape

Presented by: Nicholas Masto (nmasto1214@gmail.com)

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Animals balance costs of anti-predator behaviors with resource acquisition to minimize hunting and other mortality risks and maximize their physiological condition. This inherent trade-off between forage abundance and quality, and mortality risk is intensified in human-dominated landscapes because fragmentation, habitat loss, and degradation of natural vegetation communities is often coupled with artificially-enhanced vegetation (i.e., food plots) creating high-risk high-reward resource selection decisions. Our goal was to evaluate autumn–winter resource selection trade-offs for an intensively hunted avian generalist. We hypothesized human access was a reliable cue for hunting predation risk and thus predicted resource selection patterns would be spatiotemporally dependent upon levels of access and their perceived risk. Specifically, we evaluated resource selection of local-scale flights between diel periods of 426 mallards (Anas platyrhynchos) relative to wetland type, forage quality, and differing levels of human access across hunting and non-hunting seasons. Mallards selected areas that prohibited human access and generally avoided areas that allowed access diurnally, especially during hunting season. Mallards compensated by selecting for high-energy and greater quality foraging patches on allowable human access areas nocturnally when they were devoid of hunters. Post-season selection across human access gradients did not return to pre-hunting levels immediately, perhaps suggesting a delayed response to reacclimate to non-hunted activities and thus agreeing with the assessment mismatch hypothesis. Last, wetland availability and human access constrained selection for optimal natural forage quality (i.e., seed biomass and forage productivity) diurnally during pre-season and hunting season, respectively; however, mallards were freed from these constraints nocturnally during hunting season and during post-season. Our results suggest risk-avoidance of human-accessed areas is a primary driver of resource selection behaviors by mallards and could be a local to landscape-level process influencing distributions, instead of forage abundance and quality, which has long-been assumed by waterfowl conservation planners in North America. Broadly, even an avian generalist, well-adapted to anthropogenic landscapes, avoids areas where hunting and human access is allowed. Future conservation

planning and implementation must consider management for recreational access (i.e., people) to be as important as foraging habitat management for waterfowl during winter.

Better Understanding Effects of Climate Change on Conservation of Breeding Waterfowl in the Prairie Pothole Joint Venture: A Review

Presented by: Heath Hagy (heath_hagy@fws.gov)

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Waterfowl conservation in the U.S. Prairie Pothole Region (PPR) involves substantial investments of staff, resources, and money, the focus of which may shift as climate change influences wetlands, land use, and waterfowl populations. We reviewed available peer-reviewed publications on climate change in the PPR and identified patterns of research and predicted change that can help guide strategic waterfowl conservation. First, we noted the contrast between direct effects (e.g., drying of wetlands), which received much attention in the early literature, and indirect effects (i.e., expansion of cropland in a warmer, wetter climate), which received more emphasis recently. Second, wetter is not always better for wetlands and waterfowl, as the dynamic nature of prairie potholes contributes greatly to their productivity and value. Third, the quantity, quality, resolution, and spatial coverage of data used in climate change research have varied over time, which can have a substantial influence on the reliability and value of inferences. Our review suggests that direct effects of climate change may have less influence on waterfowl populations than indirect effects. Early scenario analyses suggested that conservation efforts be shifted to the eastern PPR, which was predicted to become wetter while the western PPR dried out; later, more comprehensive analyses generally indicate that current priority areas are appropriate. Finally, our understanding of climate change and conservation in the PPR continues to evolve as new data and insights become available. Recommendations include 1) continuation of wetland and grassland protection efforts through a large-scale prioritized approach; 2) thoughtful geographic dispersal of conservation efforts within geopolitical and biological constraints; 3) adapting conservation efforts as circumstances and knowledge change; and 4) directing research and monitoring to address key assumptions and uncertainties at appropriate scales, rather than reacting to scientific publications that may only tangentially address applied conservation.

The Sea Duck Joint Venture: Accomplishments and Future Directions

Presented by: Kate Martin (kate_martin@fws.gov)

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An increased awareness of sea duck population declines and the paucity of data on basic sea duck ecology spurred the creation of the Sea Duck Joint Venture (SDJV) in 1999 under the auspices of the North American Waterfowl Management Plan. The SDJV is a self-directed partnership co-chaired by the U.S. Fish and Wildlife Service and Canadian Wildlife Service and includes members from federal, state/provincial, and non-governmental organizations in the U.S. and Canada. The SDJV works with partners to develop, fund, and communicate the results of research and monitoring that addresses information gaps related to the management and conservation of North American sea ducks. Through supporting over 170 research projects to date, the SDJV has delineated populations, identified population-limiting factors, and characterized migratory routes and important habitats for several species. Over time, the focus of the SDJV has evolved from resolving basic ecological questions to prioritizing work explicitly linked to conservation and management actions. The SDJV has provided guidance on monitoring priorities and sea duck harvest sustainability and developed survey methods including improved species detection and identification techniques. More recently, the SDJV developed the Sea Duck Key Habitat Sites Atlas that identifies 85 sites most critical to sea duck populations in North America to aid in habitat protection, marine spatial planning, and environmental assessments. In addition, the SDJV Student Fellowship Program supports early career biologists contributing to sea duck research and conservation. We briefly describe the SDJV partnership, the priorities set in the 2022 SDJV Strategic Plan, and the process for soliciting and selecting projects for SDJV funding. We highlight recent SDJV-supported research contributing to the science and management of sea ducks, describe information gaps and priorities that we hope to address in the future, and provide tips to improve the competitiveness of proposals and fellowship applications submitted to the SDJV.

Can the Lessons from the North American Waterfowl Management Plan Be Leveraged for Shorebird Conservation

Presented by: Christian Roy (christian.roy@ec.gc.ca)

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The North American Waterfowl Management Plan (NAWMP) is often touted as one of the most successful wildlife management programs in the world and its success has been directly linked to the engagement from hunters in harvest management and in waterfowl habitat protection. Meanwhile, shorebird populations have declined by 33% in the last 50 years and the rate of decline is accelerating for most species. Shorebird declines have been linked to many threats, including unsustainable rates of harvest in the Caribbean and northeastern coast of South America. While a substantial amount of effort has recently been dedicated to documenting the harvest of shorebirds and assessing sustainability, meaningful engagement with hunters over shorebird conservation remains limited. Few initiatives have been able to replicate the NAWMP success due in large part to the differences in the community of users and supporters. Nevertheless, we believe that the recent shift in NAWMP priorities to formally integrate a more diverse group of stakeholders in wetland and waterfowl conservation could help inform a more substantial engagement with international shorebird hunters. Namely, work with human dimensions specialists, hunters, and other stakeholders could yield better conservation outcomes for harvest management and habitat conservation on the migrating and wintering grounds compared to simply assessing harvest levels. NAWMP's focus on stakeholder inclusion, habitat protection, and harvest management offers a roadmap for shorebird conservation but it will need to be applied across the entire life cycle of shorebirds to be successful.

Habitat Selection of American Black Ducks Wintering in an Urban Estuary with Increasing Shellfish Aquaculture

Presented by: Tori Mezebish Quinn (tmezebish@uri.edu)

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Waterfowl that winter in urban coastal estuaries are subjected to elevated anthropogenic activity, which increasingly includes shellfish aquaculture. However, the impacts of shellfish aquaculture on the spatial ecology of waterfowl are poorly understood. We deployed backpack-style GPS-GSM transmitters during winter 2020-2021 to monitor the movements of adult American black ducks (female n = 14, male n = 16) in coastal Rhode Island. Our final sample included 26 individuals monitored at 2 hr intervals that displayed high within and across-winter fidelity to their initial capture site on coastal waterbodies. Black ducks had bimodal movement distributions dominated by short steps that indicated movement between either coastal or inland waterbodies but also including longer steps that reflected shifts in locale between coastal and inland waterbodies. We fit an individual-specific integrated step selection model to quantify the influence of proximity to shellfish aquaculture operations on the habitat selection and movement rate of black ducks relative to environmental factors believed a priori to influence space use. At the population level, black ducks selected areas nearer to aquaculture operations, which may reflect high use of estuarine waters where aquaculture operations are located. At the individual level, habitat selection patterns differed depending on which coastal waterbody was their primary wintering site. This suggests that the high local-scale site fidelity of black ducks wintering in Rhode Island influences habitat selection behavior. Movement patterns of black ducks significantly changed for 10 individuals when close to aquaculture. Most (8) of those individuals moved more quickly when closer to aquaculture, a pattern that may be related to where aquaculture operations are typically located (i.e., in shallow, nearshore waters). These results can be used to inform the siting of shellfish aquaculture leases relative to wintering black duck space use patterns in coastal Rhode Island and similar systems where aquaculture continues to expand.

Non-Breeding Habitat Selection of Blue-Winged Teal Throughout the Central and Mississippi Flyways

Presented by: Brett Leach (balhvr@missouri.edu)

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The nonbreeding season is a critical period for waterfowl throughout the annual cycle. Habitat conditions experienced during the non-breeding season can influence body condition and subsequent reproductive effort for a range of waterfowl species, leading to the potential for cross-seasonal effects on populations. Understanding how landscape composition and proximity to a range of habitat types influences habitat selection can help prioritize conservation efforts. We investigated habitat selection during the non-breeding season for blue-winged teal (Spatula discors, BWTE), an early autumn and late spring migrant. We deployed GPS/GSM transmitters on 176 adult female BWTE during the spring in Louisiana (n=116) and during autumn in the Prairie Pothole Region (South Dakota, n= 51; Saskatchewan, n=9) in 2019-2022. We used an integrated step selection analysis to evaluate BWTE habitat selection at multiple spatial and temporal scales. Results indicate during spring and autumn, BWTE selected for areas with large amounts of emergent wetlands, open water, and cultivated crop in the surrounding landscape and selected locations near these three habitats in spring, whereas in autumn they selected to be near emergent wetlands and open water. In spring, BWTE selected to be near woody wetlands during the day and further from woody wetlands throughout autumn. During winter, BWTE selected areas with large amounts of emergent wetlands, regardless of diel period. At night selection was highest for areas with more open water and cultivated crops and less of these habitat types during the day. During the day BWTE selected to be in close proximity to emergent wetlands, open water, and cultivated crop, while at night they selected to be near emergent wetlands and woody wetlands. Habitat selection patterns for an early autumn and late spring migrant can be used to inform future habitat management decisions at major stopover and wintering locations throughout the Mississippi and Central Flyways.

Evaluating Potential Drivers of Spring Migration Departure for Northern Pintail Wintering in the Central Valley of California

Presented by: Aliya McCarthy (aliya.mccarthy@oregonstate.edu)

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The timing of spring migration in migratory ducks is a critical aspect of their life history, yet the underlying mechanisms triggering the onset of migration remains poorly understood. Both endogenous and environmental factors widely influence individual departure schedules and understanding their role in migration decision-making is essential for effective conservation and management planning. We used a high spatiotemporal resolution tracking dataset to evaluate potential mechanisms driving the initiation of spring migration for northern pintail (Anas acuta) in the Pacific flyway. We marked wintering pintail in the Central Valley of California with GPS-GSM transmitters between 2015-2023. To quantify the temporal patterns of migration departure, we analyzed 209 spring migration tracks and identified the day of migration initiation (i.e., departure date) for each pintail during the migration period. We used generalized linear mixed models to test for effects of body condition, water availability, winter weather conditions, and migration strategy (including route and breeding latitude) on departure timing from the wintering grounds for spring migration. We assessed competing models to examine temporal variations in spring migration chronology at both large and local spatial scales. Results indicate that the most important predictors of pintail departure are changes in water availability on the landscape and individual migration strategy to their breeding grounds. Our findings provide further insight into the mechanistic reasons that drive migratory timing decisions at the individual and population level and fill information gaps needed in agent-based modeling efforts used for full life cycle conservation planning.

Contrasting Migratory Chronology and Routes of Lesser Scaup

Presented by: Laurie Hall (lahall@usgs.gov)

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Migration allows birds to maximize fitness by exploiting seasonal resource peaks and avoiding limitations. Migration strategies may differ among individuals within a species, but for all strategies, the benefit of increased fitness must outweigh the costs of migration. These costs can include increased mortality risk, time constraints in the annual cycle, and metabolic energy loss. We compared migratory chronology and routes of individuals from a broadly distributed species of waterfowl, the Lesser Scaup (Aythya affinis; hereafter Scaup), marked at the northern (66.51000° N, 145.98556° W) and southern (44.63778° N, 111.73694° W) extents of its breeding distribution in North America. Scaup breeding farther North in interior Alaska, USA migrated greater distances and had protracted migrations, especially in fall, compared to Scaup breeding farther South in southwest Montana, USA. During migration, Scaup breeding in Alaska used more staging and stopover areas compared to Scaup breeding in Montana. Scaup breeding in Alaska also spent less time at their breeding area and more time at their wintering areas compared to Scaup breeding in Montana. In addition, Scaup breeding in Alaska were largely absent from wintering areas in the Intermountain West that were used by Scaup breeding in Montana. These differences could have important effects on Scaup fitness and could contribute to differences in fecundity and recruitment observed across the Scaup's broad latitudinal distribution. Understanding the fitness implications of intraspecific variation in migration strategies of broadly distributed species can assist resource managers by focusing conservation efforts on specific breeding populations, informing models of disease transmission, and improving projections of species' responses to environmental change.

Hunting Constrains Wintering Mallard Response to Habitat and Environmental Conditions

Presented by: Cory Highway (chighway42@tntech.edu)

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The spatiotemporal allocation of activity is fundamental to how organisms balance energetic intake and predation risk. Activity patterns fluctuate both daily and seasonally, and they are proximately affected by exogenous and endogenous conditions. For birds, flight activity is often necessary for relocating between foraging patches but is energetically expensive and can increase mortality risk. Hunted species may have to adjust their behavior and activity patterns to minimize anthropogenic mortality risk. We used hourly locations from 336 GPS-marked mallards (Anas platyrhynchos) to examine how hunting pressure affected flight activity in response to weather conditions and habitat availability during winter. Mallards were more likely to fly during crepuscular times, particularly dusk, across winter months. Mallards conducted more flights after shooting hours when habitat availability increased during open hunting season; conversely, mallard flights decreased with increasing habitat availability when hunters were present on the landscape. Mallards were least active during periods open to hunting. However, indicators of approaching inclement weather (i.e., increased wind speed, precipitation, and decreasing barometric pressure) increased flights during periods open to hunting. Mallard flights decreased at lower temperatures except when hunting season was closed, wherein mallards increased nighttime flights. Flight activity was directly influenced by hunting disturbance which constrained when and how mallards reacted to environmental and habitat conditions. An understanding of the temporal shifts in waterfowl flight patterns can be used by natural resource managers to better manage stakeholder satisfaction.

Evaluating Waterfowl Use of Rice Agriculture in California's Central Valley Under Shifting Landscape Conditions

Presented by: Cory Overton (coverton@usgs.gov)

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Rice is an important crop to waterfowl in California and often acts as a surrogate wetland in a state that has lost over 90% of its historical wetlands. The amount and location of rice grown in the Central Valley is often tied to water availability. Years of extreme drought, such as experienced in 2021/2022, resulted in major shifts in agricultural practices, including the fallowing of large proportions of the valley's rice. Here we've mapped acreage of rice in the Central Valley of California from 2015 to 2023 and categorized flooding regimes to relate to waterfowl habitat use and movement. We leveraged a GPS telemetry dataset of 8 species of dabbling ducks (Northern Pintail, Mallard, Gadwall, Northern Shoveler, Green-winged Teal, Cinnamon Teal, Blue-winged Teal, and American Wigeon), consisting of approximately 1.4 million locations within the Central Valley Joint Ventures waterfowl planning basins, to inform our understanding of waterfowl use and dependence on rice agriculture. Telemetry data was collected from 2015 to 2023. Temporal patterns in rice condition (pre planting, flooded pre-emergent, flooded emergent, dry post-harvest, and flooded post-harvest) in relation to duck occupancy allowed us to understand when rice is important to each species throughout the annual cycle. In 2022, when large swaths of rice fields went unplanted, we investigated the effects that the loss of this major agricultural food/habitat subsidy and the seasonal change in foraging habitat availability had on waterfowl in the Central Valley. We present the impacts that the loss of this agricultural habitat has on species distributions, movement patterns, patch use, and shifts in use of alternative habitat types (e.g., wetlands on wildlife areas and duck hunting clubs). Information from this study can help wildlife managers prepare for changes in waterfowl habitat needs under shifting climactic and agricultural conditions.

Impact of Temporal Refuge on Hunter Success at a Texas Wildlife Management Area

Presented by: Trey McClinton (herman.mcclinton@tpwd.texas.gov)

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Waterfowl hunting has immense socio-economic value in North America. Managers of agency operated properties are routinely tasked with providing quality hunting opportunities in addition to meeting habitat objectives. The impact of anthropogenic disturbance on waterfowl behavior is well documented; however, uncertainty surrounding the benefit of temporal refuge (i.e., rest days) on hunter success remains. The Justin Hurst Wildlife Management Area (JHWMA), located near Freeport, TX, consists of 6,070 hectares of tidal brackish marsh, freshwater impoundments, coastal prairie, and bottomland hardwood forest. The JHWMA hosts managed waterfowl hunts throughout the state's early teal, youth and veteran/active-duty, and regular duck seasons. There are 66 total hunt locations on the property available for selection through an in-person, day-of lottery. Locations are routinely closed to provide areas of temporal refuge. During hunts, JHWMA personnel record data on hunter use and success through a staffed check station. We generated a candidate set of 12 linear mixed models to assess the impact of temporal refuge on hunter success, as measured by birds harvested per hunter trip (BPH), over 5,664 hunt events. The candidate models consisted of various parameterizations of temporal refuge modeled both independently and in conjunction with a habitat classification. Year and hunt location were included as random effects in all models. The most parsimonious model, when compared using Akaike information criterion (AIC), indicated a positive linear relationship between BPH and the number of days since a location was last hunted (β= 0.057, 95% CI: 0.045, 0.069). While a suite of factors may influence hunter success on a given day, our results indicate that temporal refuge can provide measurable benefit to hunter success. As such, we encourage incorporating temporal refuge as a management tool for properties with a waterfowl hunting focus.

Winter Habitat Selection of Mallards (Anas Platyrhynchos) and American Black Ducks (Anas rubripes) on Eastern Long Island, NY

Presented by: Riley Stedman (rpstedma@syr.edu)

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Investigation of habitat selection by waterfowl is important for prioritizing habitat conservation efforts. Wintering mallards (Anas platyrhynchos) and American black ducks (A. rubripes; hereafter black duck) use freshwater wetlands, salt marshes, and corn fields on eastern Long Island to meet nutritional needs and survive winter. However, traditional wetland habitats are decreasing and are increasingly degraded from urbanization and sea level rise, among other stressors. Although agriculture is regularly seen as detrimental to wildlife habitat, corn fields could provide valuable supplementary nutrition to buffer potential winter food limitations and sustain green space in increasingly urbanized landscapes. I affixed 54 GPS/GSM backpack transmitters February-March in 2022 and 2023 (20 and 34 units, respectively) to track winter movements of mallards and black ducks on eastern Long Island and along their spring migratory route to determine percent time spent in freshwater wetlands, saltwater marshes, and agricultural fields through resource selection function (RSF) models. Preliminary results show a strong avoidance of developed and forested landcover types. Strong selection for open water and wetlands is shown throughout the day, with added selection for cultivated crops at dusk. Additionally, effects of precipitation or snow events and differences between mallards and black ducks will be evaluated. Results will inform habitat managers about the selection of these cover types during the critical winter and spring-migration periods of mallard and black duck annual cycles.

Wetland Bird Use and Management of Louisiana and Texas Gulf-Coast Ricelands

Presented by: Frances Buderman (fbuderman@psu.edu)

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Agricultural lands are dominant landscapes across North America. Croplands, wetlands, and uplands juxtaposed within these landscapes form habitat complexes that influence abundance and distribution of waterfowl and other wetland birds. Within the Gulf of Mexico Coastal Prairie ecoregion, the Chenier Plain and Texas Mid-Coast are agricultural landscapes used mainly for rice production. These ricelands support millions of resident and migratory waterfowl and other waterbirds as they are often comprised of interspersions of production and temporarily idled rice fields, other agricultural lands, natural wetlands, pastures, and may occur adjacent to forests and urban areas. To explore how agricultural activities and land use composition influenced the distribution and abundance of waterbirds, we quantified factors associated with waterbird species richness by conducting diurnal surveys in production, seed-, and idled-rice fields from August–March 2010–2013. This period of fall–early spring spanned rice-harvest, fall-migration, wintering, and spring-migration periods for waterfowl and other birds. We conducted 5,002 surveys in 142 fields and detected 20 waterfowl, 9 shorebird, 14 wader, 3 rail, and 7 species of other birds. In modelling species richness, we found water depth (ordered from highest to lowest richness: shallowly flooded, moderately flooded, deeply flooded, and mud), vegetation density (negative relationship), and proportion of the field inundated (positive relationship) best explained variation in waterbird richness, after accounting for spatio-temporal autocorrelation of observations. Species richness also increased with decreasing distance to the closest state or federal wildlife refuge. Forthcoming analyses will focus on the relationships between agricultural activities and land use composition and abundances of waterbirds. Coupling the inference obtained from analyses of richness and abundance will inform landscape waterbird conservation in riceland regions.

Associating Sea Ducks with Coastal Habitats in British Columbia

Presented by: Bruce Harrison (b_harrison@ducks.ca)

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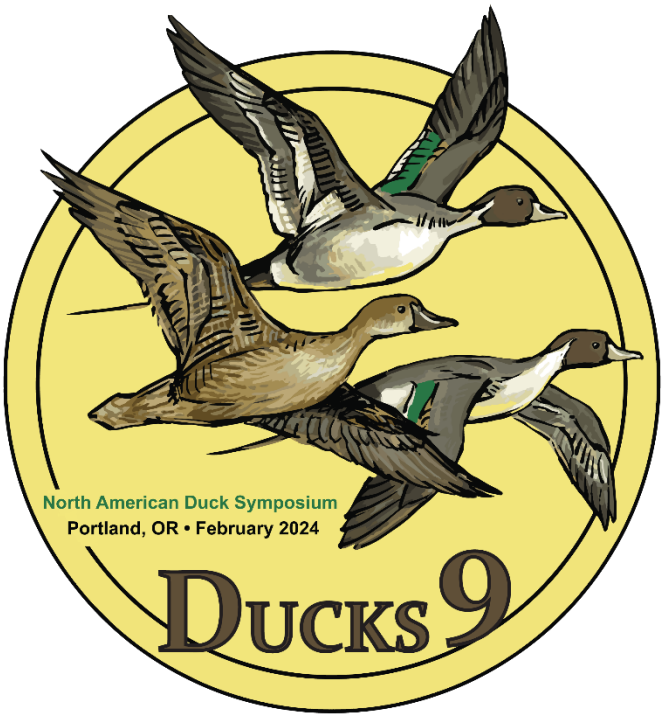
The coastal waters of British Columbia support significant populations of Pacific sea ducks, though habitat requirements of these species are poorly understood, making it difficult to prioritize conservation actions. We used mixed-effects models, utilizing 22 years of winter waterbird survey data from 268 sites along the BC coast and biophysical spatial data of this coastline to identify habitat attributes associated with the abundance of two prominent species of sea ducks: bufflehead (Bucephala albeola) and surf scoter (Melanitta perspicillata). For bufflehead, the best-approximating model accounted for about 60% of the variability in birds counted per site and included an effect of geographic region. The model predicts fewer buffleheads present on the most northern- and western-located coastlines. Bufflehead abundance was positively influenced by the presence of eelgrass and kelp, and was negatively associated with areas of rock and rock-sediment substrates, the number of inlets and with deeper water. For surf scoter, the best-approximating model accounted for about 40% of the variation in bird counts. This model predicted higher scoter abundance at intermediate latitudinal locations along the BC coast. Surf scoter abundance was positively associated with the presence of shellfish, with sediment, soft, rock, and rock-sediment substrates, and with shorelines that are sinuous, highly exposed, and steeply sloped. The abundance of surf scoters was negatively influenced by the presence of barnacles, fucus species, and by deep water. Using these models, we created predictive spatial mapping products for bufflehead and surf scoter distribution long the BC coast. This conservation planning tool assists in identifying the best areas of coastal shoreline habitat to protect, restore and prioritize actions in after disasters such as oil spills.

Poster Abstracts



Poster-1

Per- and Polyfluoroalkyl Substances (PFAS) and Waterfowl: Origins and Impacts

Presented by: Kai Victor (kvictor@ducks.org)

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Perfluoroalkyl and polyfluoroalkyl substances (PFAS) are a large class of poorly biodegradable anthropogenic chemicals known to be harmful to biological organisms. PFAS have been used for almost a century in various industrial products worldwide and are prevalent aquatic ecosystem contaminates. We reviewed and synthesized published literature to develop a brief summary of the origin of PFAS, their history of use, health risks for humans and animals, and how they interact with wetlands and waterfowl. PFAS are associated with many health concerns including cancer and developmental issues in humans and animals. In wetlands, they bioaccumulate in plants, sediments, aquatic invertebrates, and vertebrates. These sources of contamination all act as potential vectors of exposure for waterfowl, which are known to be detrimentally affected by PFAS. Due to frequent consumption of harvested birds, waterfowl hunters could be at increased risk of PFAS exposure if concentrations in waterfowl are elevated or widespread. We recommend that additional research is needed to document factors contributing to PFAS biomagnification in waterfowl, pathways of PFAS exposure, prevalence and distribution of elevated PFAS concentrations in waterfowl, effects of PFAS on the health and survival of wild waterfowl, and the role of wetlands in mitigating PFAS exposure to waterfowl and hunters. These data will enable more informed management of waterfowl populations and effective communication of risks and mitigation measures for PFAS exposure in waterfowl.

Poster-2

A New Era for Wetland Monitoring: Exploring Remote Sensing Options for Monitoring Wetland Vegetation Communities

Presented by: Katherina Schroyer (ks047428@uamont.edu)

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Big Lake National Wildlife Refuge is a wetland complex in northeast Arkansas comprised of seasonally and semi-permanently flooded areas with floating-leaf aquatic vegetation, scrub-shrub and floodplain forest, open water, and emergent vegetation. Currently, those open water areas are dominated by American Lotus (Nelumbo lutea), thus requiring periodic drawdowns to consolidate sediments, control invasive species, and allow active management activities. Documenting high resolution vegetation composition before and after a drawdown is important for informing future management decisions of emergent wetlands. We created a land cover classification model using 3x3 meter resolution PlanetScope imagery to monitor monthly and yearly changes in vegetation communities from Jun–Nov 2021–2023. We used ArcGIS Pro software to build a deep learning model, with a ResNet34 as the foundation of the U-Net architecture's encoder process. We used a U-Net deep learning modeling framework because of its effectiveness at pixel-based classification. We used training data from ground referenced observations to inform the model using 25 epochs, a batch size of 8, and a 0.0001 learning rate. An early stopping parameter was also employed to stop training if the model was no longer improving to avoid overfitting. A hand-editing process was used to correct mapping errors and misclassified pixels. In addition, we used the model created for Big Lake National Wildlife Refuge to classify the land cover composition of Mathews Brake National Wildlife Refuge to test the overall model performance. We anticipate this tool will help refuge staff in other wetland areas with similar vegetation communities to better understand and monitor the effects of management practices across the landscape on meeting habitat objectives for waterfowl and waterbirds.

Poster-3

Variation in Survival and Harvest Rates in Florida Mottled Duck

Presented by: Joshua Dooley (joshua_dooley@fws.gov)

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The Florida mottled duck (Anas fulvigula fulvigula) inhabits a relatively small range of approximately 90,000 km2 within peninsular Florida, USA, and is threatened by habitat loss and genetic introgression with feral mallards (Anas platyrhynchos). We used band-recovery and recapture data from 2000–2013 to examine geographic and demographic factors that influence the survival of Florida mottled ducks and to determine whether survival and harvest probabilities have changed over time. Mean survival probabilities were higher for birds banded in the southern portion of their Florida range than for those banded in the northern portion and higher for adult males than for adult females in both areas. Harvest probabilities increased in the northern extent of its range in Florida for adults and juveniles and remained relatively constant in the southern portion of its range during the study period. Mean harvest probabilities for adult males in both areas were higher than for adult females. Mean harvest probability for juvenile females was higher than that for juvenile males in the north but was similar between the sexes in the south. Our results suggest that mortality rates are generally greater in the northern portion of the Florida mottled duck range because of regional differences in habitat distribution and permanence and in how mottled ducks and humans use wetlands in these areas. We suggest increasing conservation efforts in the north portion of the Florida mottled duck range and improving inferences from leg banding by incorporating live recapture data.

Poster-4

Morphological Consequences of Anthropogenic Hybridization Between Introduced Mallards and Endemic Grey Ducks of New Zealand

Presented by: Miranda Fuentes (mafuentes8@miners.utep.edu)

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New Zealand grey ducks (Anas superciliosa superciliosa," grey duck") are 1 of 14 species of the Mallard Complex. Ancestrally allopatric to the other species, the release and establishment of mallards (A. platyrhynchos) in New Zealand has resulted in geographically widespread introgressive hybridization and remains a proximate threat to grey duck conservation. Understanding the consequences of hybridization between these two species that has been occurring over the last 75 years will help determine and foresee the long-term effects and future of these species in New Zealand. In fact, recent genomic assessments suggest that mallard establishment in New Zealand to some extent benefited from adaptive introgression of ecologically adapted grey duck genetic variation. Toward understanding whether these mallards indeed represent a case of hybrid vigor, we provide the first mechanistic study by assessing bill morphology, including lamellar density across 88 genetically verified mallards, grey ducks, and hybrids, using a combination of caliper-based and 3D Geometrics morphometric techniques. We found no statistical difference for general bill lengths among the three but found that bill volume was statistically different for grey ducks as compared to mallards and contemporary hybrids; no difference in volume was found between mallards and contemporary hybrids. Together, we conclude that mallards and contemporary hybrids have increased morphological variation compared to grey ducks, suggesting they can have a more variable diet. Such a scenario is consistent with a scenario of hybrid vigor, which may be attributable to the changing ecology of New Zealand towards more agricultural and urban settings. Future work will benefit from diet analyses of these birds to determine whether innate morphological differences translate to variable and more adaptable diets.

Poster-5

Wood Duck Reproductive Success and Brood Ecology from Artificial Nest Boxes in the Delmarva Peninsula

Presented by: Blake Struthers (blakestr@udel.edu)

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Many studies on wood duck breeding ecology address some aspects of artificial nest box placement or construction. Comparatively few, however, investigate the fates of ducklings after leaving the nest. Information on fine-scale habitat use and subsequent effects on survival is even scarcer. The Delmarva Peninsula is an ideal location to address these knowledge gaps as it features many diverse habitats across wooded inland wetlands and open coastal marshes that are suitable for nesting wood ducks. During the 2023 nesting season, we marked 39 hens (20 nesting in open marsh and 19 in forested wetland habitat) with solar-powered GPS-UHF backpacks with glue-on VHF units. Three randomly selected ducklings from the brood of each marked hen received VHF prong and suture transmitters for a total of 117 ducklings marked. We tracked broods every 1-3 days for a maximum of 30 days after hatch or until all three marked ducklings either died or were censored. We randomly selected one GPS point per brood per day to sample ground cover percentage with a 0.5m x 0.5m Daubenmire frame. Broods nesting in inland habitats traveled an average 54% further straight-line distance from nest box to brood rearing area than coastal broods. Coastal broods selected habitats with more emergent aquatic vegetation and taller vegetation than inland broods. Inland broods utilized areas with greater canopy cover, more plant litter, and more submergent aquatic vegetation than coastal broods. Thirty-day duckling survival was 0.19 and 0.21 for coastal and inland ducklings respectively. Coastal broods appear to travel shorter distances to brood rearing areas with better protective cover, but inland broods experienced higher survival rates.

Poster-6

Assessing Morphology Among Mexican Ducks, Mottled Ducks, Mallards, and Their Hybrids in a Recent Contact Zone in South Texas Brush Country

Presented by: Vergie Musni (vmmusni2@miners.utep.edu)

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Western Gulf Coast mottled ducks (Anas fulvigula maculatus) and Mexican ducks (Anas diazi) are non-migratory, with the mottled duck ranging across freshwater and brackish marshes of the Western Gulf Coast region of Louisiana and Texas, while the Mexican duck adapted to the wetlands of the Chihuahuan Desert. Interestingly, both species are increasingly being recovered outside their stated ranges, with the northeastward and westward expansions of Mexican and mottled ducks. Mottled ducks are being recovered as far west as La Salle County, Texas, while Mexican ducks were found in Texas counties near the USA-Mexico border. Meanwhile, the first confirmed Mexican x mottled duck hybrids have been recovered in areas of the south Texas Brush Country between La Salle County and the USA-Mexico border. This unique phenomenon raises significant conservation and management concerns. The novel overlap has now resulted in the emergence of hybrid individuals. By using advanced 3-dimensional morphometric analyses, our study aims to provide the first mechanistic assessment of this hybridization event by investigating whether hybrid ducks exhibit distinct morphological traits compared to parental mottled or Mexican duck species. We focus specifically on the bill, as bill morphometrics have a direct association with feeding capacity, and thus, likely impact fecundity and survival. Preliminary analysis of bill volume in Mexican ducks, mottled ducks, and their hybrids did not reveal any statistically significant differences ($p>0.05$). This lack of differentiation may be attributed to a shared diet among these groups. Additionally, the observation that hybrids display bill sizes reflect those of their parent species suggests that they possess a combination of traits that yields the capacity to compete for forage resources similar to their purebred counterparts.
This finding holds important implications for their overall fitness and survival in their natural environment.

Poster-7

Breeding Origins of Waterfowl Harvested in Louisiana Derived from Band Recoveries and Stable Isotope (Δ2H) Measurements of Feathers

Presented by: Shannon Stemaly (sstemaly@agcenter.lsu.edu)

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Understanding variability in breeding origins of harvested waterfowl is important for effective population management and conservation. Throughout the Mississippi Flyway, states providing wintering habitat support cross-seasonal conservation by allocating resources to waterfowl from diverse breeding regions based on the proportion of harvested waterfowl from each region. This support is based largely on results of band-recovery efforts. However, uneven distribution of banding activity across species' breeding ranges may result in an incomplete representation of true breeding origins. Banding follows a capture-mark-recovery framework, and while important for making management decisions, its representativeness across some species ranges is incomplete and may overestimate the proportion of individuals coming from particular capture locations. Stable isotope approaches provide an alternative (intrinsic) method that does not require prior capture and marking of individuals. The stable-hydrogen isotope deuterium (δ2H) has a predictable and measurable gradient in food webs across North America. Relative deuterium abundance is fixed within metabolically inactive tissues, such as fully grown feathers, and values reflect that of a bird’s spatial environment which can be estimated through a probabilistic likelihood-based spatial assignment process. Our objective is to compare source origins of Louisiana-harvested waterfowl derived from banding data and feather isotope sampling. We collected >1800 feather samples from adult and juvenile blue-winged teal (Spatula discors), green-winged teal (Anas crecca), gadwall (Mareca strepera), lesser scaup (Aythya affinis), mallards (Anas platyrhynchos), and northern pintail (Anas acuta) harvested across Louisiana during the 2022–2023 waterfowl hunting season. These samples are currently undergoing δ2H isotopic analysis, and we intend to collect a similar sample size for the 2023–2024 season. While stable isotope techniques have been applied in breeding and mid-latitude states, little research has been conducted in wintering areas. This dataset will improve our understanding of waterfowl migratory connectivity and enable more effective conservation efforts based on identified breeding geographies.

Poster-8

Changing Forage Conditions for Molting Steller's Eiders (Polysticta stelleri) in Izembek Lagoon, Alaska

Presented by: Anastasia Maliguine (ammaliguine@alaska.edu)

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Izembek Lagoon, located in the Alaskan southern Bering Sea, is designated as critical molting and wintering habitat for the Alaska-breeding population of Steller's eiders (Polysticta stelleri), listed as Threatened under the United States Endangered Species Act. Izembek Lagoon is also an important stopover site for many other species of migratory water birds. Since the early 1980s, there has been a decline of Steller's eiders in their known nonbreeding range in the southern Bering Sea, but especially in Izembek Lagoon where eiders undergo their remigial molt during the fall. The cause of this decline is unknown, however, in recent years higher sea temperatures have been observed in Izembek Lagoon and warming ocean temperatures have been associated with shifts in benthic community structure elsewhere. If forage conditions are less favorable in Izembek Lagoon, eiders may redistribute to other locations or the population at Izembek Lagoon may decline. Therefore, in 2018 and 2019, we replicated a benthic sampling effort conducted by the United States Geological Survey in 1998 to understand if prey availability could be less favorable to eiders during their molt in Izembek Lagoon. We compared forage conditions based on the relative biomass (%) and overall biomass (g/m2) of marine benthic groups: Bivalvia, Gastropoda, Crustacea, and Polychaeta, and compared size (mm) of organisms belonging to these groups between the two time periods. Our results suggest a shift in benthic community composition and change in biomass and size of benthic prey. The community shifted from being dominated by bivalves in 1998 to predominantly polychaetes in 2018 and 2019. In addition to a reduction of bivalve biomass in 2019, bivalves and gastropods were significantly smaller. This study provides a contemporary assessment of forage conditions in a critical habitat for Steller's eiders.

Poster-9

Native Bees, Fire Ants, and Waterfowl Habitat Management in Mississippi's Alluvial Valley

Presented by: Haley Hughes (hmh248@msstate.edu)

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Seasonal wetlands help meet the biological needs of various autumn migrating and wintering waterfowl species in southern United States. Management of seasonally flooded impoundments often uses soil and vegetation disturbances to promote early succession plants that produce abundant seeds for foraging birds. Native bees (Hymenoptera: Anthophila) and red imported fire ants (Solenopsis invicta; RIFA) also occupy these wetland habitats, however, how these insects are affected by water and vegetation manipulation is little known. We designed an experiment on several areas including Panther Swamp and Sam D. Hamilton Noxubee National Wildlife Refuges, and private lands in Mississippi's Alluvial Valley (i.e., Delta). We identified twelve wetland sites and created 10-acre plots, subdividing them into two 5-acre plots. We randomly assigned wetland management methods that included either a disking, mowing, flooding, or control treatment to each of the 5-acre plots, ensuring equal representation. We established bee bowls, blue vane traps, and trap nests throughout the 5-acre plots to evaluate native bee abundance and responses to each of the assigned managements. We are also evaluating native bee response to the presence of RIFA. Six of the twelve 10-acre sites were treated with an insecticide for fire ants, while the other half serve as a control group (no insecticide treatment). Two weeks following the insecticide treatment, pitfall trap surveys were conducted to evaluate insecticide success. We will collect bees once monthly during the project's duration. Preliminary data were not yet available at the time of this submission. However, this study will be informative on how disturbances to water and vegetation in seasonal wetlands influences native bees and RIFA with respect to common waterfowl management practices.

Poster-10

Targeted Wetland Restoration to Maximize Breeding Waterfowl Habitat in Eastern South Dakota

Presented by: Samuel Kucia (samuel.kucia@sdstate.edu)

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The Prairie Pothole Region (PPR) of North America was once the largest grassland and wetland ecosystem in the world; it remains critical to breeding waterfowl, accounting for >50% of continental duck production annually. Approximately 10% of the PPR lies within South Dakota, and the critical wildlife habitats in this region are increasingly susceptible to degradation and loss due to climate and land use change pressures, particularly conversion to agriculture. Estimates suggest South Dakota has lost ~40% of its historical wetlands, but advancements in technology and increased commodity prices have led to expanded wetland drainage and conversion in the region in recent decades. Wetland restoration may counteract historical losses and return wetland structure and function to the landscape. Historically, wetland restorations have focused on maximizing restored wetland areas or taken a generalized approach intended to regain all wetland ecosystem services possible. Recent advances in remote sensing technologies and data availability offer novel opportunities to inform wetland restoration site selection that may maximize the ability to restore specific wetland functions and service outcomes. Our goal is to improve conservation planning and implementation by mapping drained wetland basins in eastern South Dakota and develop spatially explicit models that quantify basin-specific potential to serve as breeding waterfowl habitat.

Poster-11

Factors Influencing Field Selection by Mallards and Northern Pintails Within Rice-Crawfish Dominated Agriculture in Southwest Louisiana

Presented by: Aiden Gehrke (agehrke@agcenter.lsu.edu)

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Waterfowl populations of the last 100 years have existed in and responded to highly modified landscapes across their annual life history. In landscapes used throughout all waterfowl life-history events, agricultural development often has influenced the type of habitat available and the function of historic ecosystems. The Chenier Plain and coastal marsh system of southwest Louisiana has evolutionarily been a significant overwintering and spring migratory staging landscape for diverse waterfowl species and has provided critical ecological functions. However, the southwest Louisiana landscape has experienced tremendous anthropogenic changes and is currently dominated by agriculture, mainly rice (Oryza sativa) and crawfish (Procambarus clarkii) rotational production. While rice agriculture and crawfish aquaculture can provide habitat for waterfowl, production and management practices vary widely and as a result may influence waterfowl use and selection differently at the field level. This study seeks to evaluate factors that influence waterfowl use and selection of diversely managed fields (e.g. rice agriculture, crawfish aquaculture, fallow, managed wetland) within a predominately agricultural landscape. In July 2023, we established two study blocks (16 km x 16km each) to intensively cover map landcover for field-level agricultural production practices in southwest Louisiana. For all fields in rice production, we obtained data on planted rice variety as well as additional data on harvest methodology and field management. Because our study area is an active agriculture system, we updated our study block maps seasonally to capture changes at each field that are likely to influence waterfowl use. From October to December 2023, we will capture and mark wintering mallards (Anas platyrhynchos; n = 20) and northern pintails (Anas acuta; n = 20) with GPS/GSM satellite transmitters to track hourly movements within and surrounding our study blocks. We anticipate that our data will provide new inferences regarding field-level selection across a heterogeneous agricultural landscape.

Poster-12

Effects of Auditory Disturbance on Mallard and Northern Pintail Behavior in Southwest Louisiana

Presented by: Emily Ferraro (emilyferraro35@gmail.com)

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Human disturbance is one of the most important factors influencing the local distribution and movement of waterfowl, however, quantifying the magnitude and extent of disturbances has previously proven difficult. One of the most heavily disturbed but biologically important landscapes for non-breeding waterfowl is southwest Louisiana, which is characterized by economically and culturally valuable rice and crawfish farms that provide important habitat and energetic resources for migrating and wintering waterfowl. These critical habitats are also characterized by intensive seasonal hunting and agricultural disturbances that are likely to influence the movement of birds across the local landscape. The goal of this study is to quantify the movements and behaviors of waterfowl in response to local landscape disturbance. We will assess hunting pressure and other local landscape-scale disturbances using autonomous recording units (n = 40) in southwest Louisiana before, during, and after the 2023/24 and 2024/25 waterfowl hunting season. Concurrently, we will deploy subcutaneous GPS-GSM satellite transmitters on 20 northern pintails (Anas acuta) and 20 mallards (Anas platyrhynchos) to collect fine-scale movement data and quantify behavioral responses to auditory disturbance. We anticipate that results from this study will increase our understanding of the proximate factors that affect the spatio-temporal distribution and behavior of waterfowl across southwest Louisiana. Such insight has valuable applications for both private and public land managers to establish and manage local sanctuary and hunting pressure.

Poster-13

Signals of Both Purifying and Directional Selection Across the Speciation Continuum in the Mallard Complex

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Speciation as a central component of biological diversification is considered as a continuum process rather than a single event. The species' genomes are often heterogeneous due to the differential impact of many evolutionary forces that occur during the divergence process. Consequently, genomic comparisons can unravel unique evolutionary, including differential adaptive histories. We compare the full genomes of 11 (of 14) species within the Mallard Complex that radiated ~1 million years ago around the world to determine how directional and purifying selection have acted to either establish derived or maintain ancestral states, respectively. Our results show the lowest level of differentiation among the North American species, suggesting that they were at the earliest stages of divergence. In contrast, the genomes of the African Black duck and Laysan duck exhibited the highest level of differentiation, but this may be due to genetic drift given that they also harbored the lowest nucleotide diversity. Additionally, we observed stronger support for species relationships in the Z sex-chromosome phylogenetic tree, while the autosomal tree faced challenges in resolving the North American clade, likely representing a polytomy. However, both trees support the basal position of African ducks. Our PSMC analysis further supports the diversification of the mallard clade a million years ago. The FST comparisons across genomes identified Islands of differentiation across 44 species comparisons representing early- and moderate-stages of divergence, whereas valleys of differentiation were identified across 55 species comparisons representing all stages of divergence. Finally, the autosomal and Z-chromosome genes in directional selection (Hight FST) are potentially involved in adaptation and reproductive isolation.

Poster-14

Estimating Non-Breeding Waterfowl Abundance for Conservation Planning Using Citizen Science Data

Presented by: Joe Lancaster (jlancaster@ducks.org)

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Migratory Bird Habitat Joint Ventures are tasked with stepping down population objectives from national or international bird plans to their geographies as the foundation for developing habitat objectives that alleviate regional population limiting factors. For Joint Ventures like the Gulf Coast (GCJV) where waterfowl habitats serve primarily to support population energetic demands during migration and wintering periods, bio-energetic models are a common planning framework to empirically link regional midwinter population targets to habitat needs. Two critical steps in this conversion are 1) incorporating spatially explicit species-specific relative abundance (i.e., migration chronology) information across the non-breeding period, and 2) selecting the appropriate date to which seasonal objectives stepped down from the North American Waterfowl Management Plan are assigned to the migration chronology curve (i.e., anchor point). In a 2021 update, robust datasets from multi-temporal aerial waterfowl surveys used historically were no longer available, necessitating the GCJV explore alternative datasets, such as the global citizen science project eBird, to assess migration chronologies. Through an agreement with the Cornell Lab of Ornithology, we used the eBird Status and Trends weekly relative abundance data product, accessed through the R package ebirdst, to quantify species-specific migration chronology for 17 waterfowl species across 6 GCJV sub-geographies. We developed a method to calculate species-specific anchor points applicable across all JVs within autumn and winter periods. The method quantitatively identifies the day on which the distribution of harvest across JVs most closely matches the distribution of harvest across the entire period. Contemporary migration patterns and anchor point derivation survived scrutiny of expert opinion and were incorporated into 2021 refinements of GCJV waterfowl habitat objectives. We believe these methods provide a transparent and repeatable process to migratory bird conservation planning across JVs or similar-sized planning geographies.

Poster-15

Waterbird Migration Chronology and Wetland Selection in Georgetown, South Carolina

Presented by: Jordan McCall (jmccal4@g.clemson.edu)

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The South Atlantic Coastal Plain of South Carolina is essential for migrating, wintering, and breeding waterfowl and other waterbirds. However, little is known about the use of specific wetland types and the influence of wetland loss and conversion on avian habitat use. This study encompasses extensive, conserved lands and highly developed and altered landscapes along the South Carolina coast. Our primary objectives are to model winter and spring waterbird-habitat relations and document spring migration chronology along the north-central coast of South Carolina. In 2022, we performed point count surveys at 97 randomly selected wetlands, varying by type, and secretive marsh bird surveys at 12 emergent freshwater wetlands to estimate occupancy rates, species diversity, species abundance, and migration chronology from January to July. Wetland-level data (e.g., water quality, water regimes, vegetation, macroinvertebrates) were also collected to model waterbird use and selection of wetlands. Preliminary results suggest that great egrets (Ardea alba) and willets (Tringa semipalmata) are most abundant in natural wetlands, and American wigeon (Mareca americana) and snowy egrets (Egretta thula) are most abundant in altered wetlands. Shorebirds and waterfowl peaked in March, secretive marsh birds peaked in April, and wading birds peaked in June. Our results also suggest that avian diversity is greatest in estuarine and marine wetlands, potentially due to abundant macroinvertebrates. The most abundant macroinvertebrate taxa detected were chironomids (Chironomidae) and scuds (Gammaridae). In the 2023 field season, we followed the same protocol from the 2022 season, but data collection focused on the most productive wetland type from the previous season. These data will improve understanding of wetland-waterbird relations along the South Atlantic Coastal Zone and enhance the conservation and management of these wetlands for waterbirds.

Poster-16

Evaluating the Impact of Forest Disturbance on Cavity Nesting Sea Ducks in the Interior of British Columbia

Presented by: William O'Shea (william.oshea@ec.gc.ca)

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The Central Interior Plateau (CIP) of British Columbia supports some of the highest densities of breeding waterfowl in the province, including several species of cavity nesting sea ducks. This region has been subjected to decades of widespread disturbance from human activities like commercial logging. Furthermore, natural ecological processes in the region such as range expansion of the mountain pine beetle (Dendroctonus ponderosae) and large-scale wildfires have been amplified by climate change, leading to significant degradation of forest habitat. Despite this, little is known about how these disturbances, whether individually or cumulatively, have affected the distribution and abundance of cavity nesting sea ducks. We used long-term (2006-2023) helicopter survey data collected in the Fraser Plateau and Fraser Basin Ecoregions to estimate the abundance of two sea duck species demonstrating different population trajectories; Barrow's Goldeneye (Bucephala islandica) a species showing an overall population decline, and Bufflehead (Bucephala albeola) a species that has demonstrated stable population trends. While Bufflehead are widely distributed, the CIP encompasses much of the core breeding range for western Barrow's Goldeneye, meaning declines in forest habitat quality in this region may have more profound population-level effects on this species. We used landscape-level data available for the CIP to model species-specific habitat relationships, including metrics of forest disturbance, and produced estimated species distribution maps for the region based on those relationships. With climate models forecasting a greater loss of forest habitat in the coming decades, understanding how past disturbances have shaped the distribution of cavity nesting sea ducks in the CIP is critical for conservation of these species.

Poster-17

Nest-Box Mounted Pit Tag Readers Provide New Insight on Breeding Behaviors of Black-Bellied Whistling-Ducks in Louisiana

Presented by: Katie Miranda (kmiran2@lsu.edu)

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North American ducks are one of the most well-studied groups of organisms on the planet; however, we know astonishingly little about the nesting ecology of Black-bellied Whistling-Ducks (Dendrocygna autumnalis; BBWD), which are rapidly expanding into the core of the eastern Wood Duck (Aix sponsa) range. Typical field methods used to study cavity-nesting waterfowl involve capturing and banding the incubating individual and collecting nest information at regular intervals. This precludes a full understanding of important breeding information including nest prospecting and parasitic egg laying and fails to detect nests that are terminated before discovery. Here, we quantified BBWD nest box visitation during the prospecting, laying, and incubation periods using subcutaneous passive integrated transponder (PIT) tags embedded in adults and ducklings and radio frequency identification (RFID) PIT tag readers mounted on nest boxes. We deployed 20 RFID readers on 40 duplex-style nest boxes from March–December 2022 at Sherburne Wildlife Management Area with the potential to detect BBWD and WODU individuals that were previously marked with PIT tags from 2020–2022. We conducted weekly nest visits where we recorded characteristics such as clutch size, nest age, incubation stage, and presence of intra- or interspecific nest parasitism. Notably, our findings revealed that nearly half (48%) of the 48 adults detected via RFID readers were never otherwise recaptured in 2022. Additionally, we observed that known breeding pairs exclusively visited their own nest boxes during the laying and incubation periods. We also determined that BBWD preferentially visited and nested in boxes that are >1 year old ($t = 3.49$, $df = 20.30$, $p < 0.01$), while WODU did not ($t = 1.99$, $df = 18.37$, $p = 0.06$). We found that traditional methods alone fail to document important breeding behaviors, demonstrating that RFID technology can be used to reshape the way we study cavity-nesting waterfowl.

Poster-18

Varying Impacts of H5N1 Infection on Lesser Snow Geese Movement Ecology

Presented by: Jeffery Sullivan (jdsullivan@usgs.gov)

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Despite the significance of highly pathogenic avian influenza to both wild waterfowl and domestic poultry, there is little data available on how infection impacts the movement ecology of wild birds. Thus, the ability to incorporate realistic movements of infected birds into transmission modeling efforts is severely hampered. We present tracking data from a single HPAI positive wild snow goose and compare the movement and migration ecology of this bird to noninfected conspecifics. We also present serology data from additional snow geese, captured at the same location months later, which failed to migrate during the species' traditional window. We will discuss the potential implications of observed movement patterns on HPAI transmission dynamics, as well as why the impacts of infection may vary across individuals within a species.

Poster-19

Enhancing Breeding Pair Count Surveys of Ducks Through Unmanned Aerial Vehicle Implementation

Presented by: Hannah Sabatier (hannah.sabatier@outlook.com)

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Successfully hatching a clutch is a vital component of recruitment in wildlife populations, and it partly depends on when and where a nest is initiated. Upland nesting ducks are attracted to environments with intact grassland and interspersed wetlands. Therefore, breeding duck density can be used to indirectly assess habitat quality or to predict production potential during a given
year. Traditionally, breeding duck pairs have been counted from visual observers in aircraft or on the ground. Unmanned Aerial Vehicle (UAV) technology is now available to survey wildlife, this offers an advantage for wildlife survey applications. We evaluated methods for counting breeding duck pairs by comparing ground counts with binoculars to search methods using a DJI
Matrice 30T Quadcopter equipped with thermal and optical sensors at 60 independent ponds in central Saskatchewan during May 2023. We hypothesized that by increasing altitude and looking down on wetlands with variable focal length and thermal imagery, we could expect to have higher detection probability with UAVs than with binoculars. Further, we anticipated that the UAV surveys would take less time to complete and cause less disturbance. We conducted a t-test
and raw counts did not differ between UAV and ground counts on semi-permanent and permanent ponds (p-value = 0.05, p- value = 0.54) but did on wooded ponds (p-value = 0.04). On average UAVs were faster and did not cause obvious disturbance. These results demonstrate the value of UAV technology to count wildlife, and how they might improve on traditional methods, like ground surveys, by increasing efficiency while maintaining data quality.

Poster-20

Southeast Kansas Mallard GPS Project - Evaluating Mallard Fall, Winter, and Spring Ecology with GPS/ACC Transmitters

Presented by: Ethan Dittmer (dittmerethan@gmail.com)

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The Mallard is one of the most important duck species to waterfowl hunters in Kansas and makes up >50% of all duck harvest. Southeast Kansas is an important area for Kansas waterfowl harvest, particularly mallards. The southeast zone includes 4 of the top 10 mallard harvesting counties in Kansas, which accounts for 23% of mallard harvest in the state, on average, from 1997-2017. Yet, no information of how mallards use and behave in southeast Kansas exists. Bi-weekly surveys of waterfowl abundance are conducted at 9 public lands in southeast Kansas with annual report peaks of >100,000 mallards. Currently, there are knowledge gaps on habitat use, selection, behaviors, and movement strategies of mallards during the fall and winter in southeast Kansas; it is imperative that public and private land managers have up-to-date knowledge on how waterfowl use this area. Recently developed GPS/GSM transmitter technologies allow researchers to investigate both the local and regional ecology of mallards at a fine resolution. We are investigating the fall, winter, spring and breeding ecology of mallards captured during the late fall and early winter in Southeast Kansas via the deployment of Ornitela OT-E20-4GACT transmitters. We plan to deploy at least 150 devices on adult female mallards during 2023, 2024, and 2025 on public sanctuary areas within the Kansas Southeast Duck Hunting Zone. Our objectives are to investigate mallard habitat selection and energy expenditure, local and regional movements, patch-use and revisitation, spring migration, and breeding ecology. We expect that this research will inform waterfowl management within Kansas as the area is likely to see increases in duck residency time during the fall and winter due to increasingly mild winter weather conditions brought about by climate change.

Poster-21

Integrated Wetland Management for Waterfowl Conservation and Biological Control of Mosquitoes

Presented by: John Veon (jtveon@ucdavis.edu)

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Best management practices for mosquito control in California often conflict with wetland management techniques that provide high quality habitat for wetland dependent species. Specifically, reduced irrigations during spring and summer required for mosquito control can decrease moist-soil seed production for resident and migratory waterfowl. Additionally, while some pesticides used against mosquitoes have few non-target effects, others are broader-spectrum and all are costly to apply. Conservation Biological Control, which seeks to bolster native predatory arthropods to control pest species, might offer an alternative strategy for mitigating mosquito production in wetlands. We conducted a large-scale study of 12 (50-200 ha) managed wetlands at Bird Haven Ranch, CA, USA, to determine if a management strategy of ensuring that water persists in swales and macroinvertebrate predator reservoirs (i.e., ponds) can enhance predation of mosquito larva by macroinvertebrates. We compared the abundance of mosquitoes and predatory macroinvertebrates among experimental wetlands using traditional mosquito control practices (Control units: no swale flooding between full unit irrigations and no predator reservoirs) versus treatment wetlands designed to promote native predatory macroinvertebrates (Treatment units: water remaining in swales and predator reservoirs between full unit irrigations). Initial results indicate that predators were marginally more abundant in Treatment wetlands compared to Control wetlands. Further, predators were negatively correlated with depth in Treatment wetlands, but positively correlated with depth in Control wetlands. Finally, mosquito larvae were detected in greater abundance in Control wetlands than Treatment wetlands. These preliminary results suggest that Conservation Biological Control could be a viable and sustainable approach for mosquito control in managed wetlands, providing managers with a novel technique for simultaneously reducing mosquitoes and improving habitat for wetland birds and other wetland dependent species.

Poster-22

Environmental Factors Influencing Blue-Winged Teal Spring Migration Initiation and Subsequent Migratory Movements

Presented by: Jeffrey Edwards (jwepth@umsystem.edu)

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Migration is an important life history strategy that allow waterfowl access to resources that otherwise would be unavailable. Specifically, spring migrations are an integral part of the annual cycle for most waterfowl species due to the temporal proximity to the breeding season. However, migratory events are energetically demanding and access to stopover habitats with sufficient food availability is fundamental to successful completion of this life history event, with potential to exert cross-seasonal effects on waterfowl nesting and productivity. Waterfowl may schedule migratory departures based on environmental factors that provide ideal conditions to reduce energy expenditure, risk of mortality, and to improve body condition upon arriving to the breeding grounds. In this study, we investigated the potential effects of several environmental factors on blue-winged teal (Spatula discors) spring migration phenology during 2020 – 2023. Individuals were marked with 10g Ornitela GPS/GSM transmitters in south Louisiana (spring, n=189) and South Dakota (autumn, n=94). We will use Cox proportional hazard and generalized estimating equation models to evaluate how environmental variables influence blue-winged teal migration initiation dates in leaving the wintering grounds as well as subsequent migratory movements from stopover sites. We hypothesize that photoperiod will explain the greatest variation in migration initiation date, but there is limited research on other factors that may influence initiation from wintering grounds and subsequent migratory movements among stopover sites. Understanding the environmental factors that influence blue-winged teals' decision to initiate migration and depart stopover areas may provide insight into the timing of habitat management decisions in the spring most likely to benefit blue-winged teal during migration. Additionally, a broad evaluation of migratory departure dates and the factors influencing initiation may contribute context and insight into the effects of global climate change on blue-winged teal migration phenology.

Poster-23

Variation in Spring Migration Strategies of Northern Pintails and Consequences to Fitness

Presented by: Georgina Eccles (georgina_roxanne.eccles@students.tamuk.edu)

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The continental population of northern pintail remains below population objectives and a better understanding of the species' non-breeding ecology could help inform future management decisions. Conditions in nonbreeding seasons vary within the population, as pintails winter in various landscapes within the U.S., are subject to different winter stressors, and migrate through markedly different landscapes during spring migration. Investigating regional variation in non-breeding ecology may help inform some of the uncertainties of non-breeding conditions influencing fitness. The aim of this study was to investigate the influence of spring migration metrics on reproductive effort in female pintails departing from different wintering regions in the U.S. Females were captured within six important wintering regions (Central Valley of California, Southwestern Arizona, Central and Eastern New Mexico, Texas Panhandle, Texas Coast, and Louisiana Coast) and fitted with Ornitela GPS/GSM backpack style devices. Using GPS data, we delineated winter and spring periods with movement classification outputs from Hidden Markov Models. Within spring datasets, we calculated late winter body condition, GPS movement-based metrics, as well as accelerometer-derived Overall Dynamic Body Acceleration and behavioural data (classified into foraging, resting and flight). We plan to use Generalized Logistic Mixed Models to investigate the influences of above-mentioned predictors on female fitness (nesting attempt or deferral). Further, we will examine migration metrics to compare between and within wintering regions, considering the relationship between wintering region and migration strategies (time vs

energy minimization strategies). This ongoing study aims to test hypotheses on predicted strategies in females from differing wintering regions and address some of the mechanisms constraining breeding propensity.

Poster-24

Morphological Consequences of Anthropogenic Hybridization Between Domestic Game-Farm Mallards, Wild Mallards and Hybrids

Presented by: Diane Martinez Ricartti (dlmartinezr@miners.utep.edu)

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The domestic game-farm mallard (Anas platyrhynchos domesticus) breed threatens wild mallard populations through extensive and geographically widespread hybridization. Although the domestication process indeed resulted in significant genetic differences between game-farm and wild mallards, whether these molecular differences translate to morphological and behavioral variation remains unknown. Indeed, the domestication process imposes artificial selection that often has rapid and direct changes in morphology compared to the wild ancestors, and often for traits less suited for wild settings. We tested for morphological differences between wild and game-farm mallards, and use hybrids of varying wild genetic ancestry to determine the heritability of these traits. In short, we assessed bill morphology, including lamellar density across 158 genetically verified wild, game-farm, and wild x game-farm hybrids, using a combination of caliper-based techniques and scanning technology. Preliminary analyses found that game-farm mallard bills were significantly different from their wild ancestors, and that bill morphology correlated with genetic ancestry, with birds possessing >80% wild ancestry having bill morphology like reference wild mallards. These results suggest that bill morphology is heritable, and that interbreeding between these types in the wild likely translates to mechanistically different birds. Given the importance of bill morphology to diet, it will be critical to determine how these differences translate to feeding efficiency in the wild. Birds that are incapable of attaining sufficient calories can translate to poor demographics and declining populations. Such comparisons are key in understanding how these interactions are impacting the adaptability of wild mallard populations.

Poster-25

Validating Field Observations with Molecular Sequencing to Quantify Interspecific Brood Parasitism

Presented by: Michael Johnson (mk.johnson@colostate.edu)

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Validating the accuracy of field observations is an important component for maintaining consistent and sound science over time where study sites and field crews are likely to change. To inform our primary objective of quantifying the demographic impacts of interspecific brood parasitism, we visually identified the number of parasitic redhead eggs within parasitized canvasback nests using eggshell color, texture, and incubation stage as cues. These two species' eggs can often resemble one another, and repeated misclassifications would have implications for parameters used in population growth models. To test the accuracy of our field observations, we collected a sample of eggshell membranes for mitochondrial DNA sequencing. Results from molecular species identification were compared with initial field observations and categorized further by technician experience (e.g., first field season, 2-3 years' experience, 5+ years' experience) to estimate the accuracy of field crews and to inform parameters associated with interspecific brood parasitism, host clutch size, and loss of host eggs in parasitized nests.

Poster-26

Domestication Results in Physiologically Different Birds: Quantifying Muscle Fiber-Types of Wild, Game-Farm, and Hybrid Mallards

Presented by: Nicholas Enriquez (naenriquez2@miners.utep.edu)

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In eastern North America, captive-reared, game-farmed mallards (Anas platyrhynchos domesticus) are released annually in mass to supplement wild populations for hunting, dog training, etc. Recent landscape genomic studies have proved that these releases resulted in extensive introgressive hybridization with wild mallard populations. In short, captive-reared mallards are often physiologically, morphologically, and behaviorally different from their wild ancestors but the extent of these differences between wild mallards and the specific game-farm breed that is being released remains relatively unknown. Towards this, we aim to quantify muscle fiber type across 10 of each genetically vetted wild, game-farm, and wild x game-farm hybrid mallards. Variation in muscle fiber composition is directly responsible for differences in flight behavior due to the inherent mechanical function of the three avian skeletal muscle types. The muscle fiber types of the pectoralis major muscle were categorized and quantified using immunohistochemistry. Preliminary analysis suggest that all pectoralis muscles examined across wild and game-farm mallards contained exclusively fast glycolytic fibers (FG) and fast oxidative glycolytic fibers (FOG). However, variation existed in FG and FOG fiber concentration between wild and game-farm mallards that potentially suggests the variability in flight behavior. Future research will require increasing sample size to test for significance, including understanding the genetic underpinnings for these differences.

Poster-27

Modeling Changing Winter Waterfowl Distribution in Ohio and the Great Lakes Region

Presented by: Andrea Spurck (spurck.4@osu.edu)

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Warming winter temperatures have affected duck distributions across the United States. Previous studies have reported and predicted delayed autumn migration and northerly shifts in wintering ranges. Much previous research has been conducted on a continental scale with little focus on finer scale geographic impacts. Ohio is an important state to consider in this context because its location is in the lower Great Lakes region. Increased abundance of wintering ducks in Ohio could place greater demand on food and habitat, limiting resources available during spring migration. Shifts in waterfowl distributions could also result in potential changes to waterfowl hunting and viewing opportunities at different latitudes. My first objective is to conduct a retrospective analysis to assess Christmas Bird Count trends in dabbling and diving duck distribution and relative abundance from 1966 to 2021. This will involve modeling associations between winter temperature and other factors through time. My second objective is to conduct a prospective analysis to predict future winter duck distribution and relative abundance based on varying climate change projections. My third objective of the proposed research is to model historic aerial fall survey count data collected by the Ohio Division of Wildlife (1986-2022) as a function of explanatory variables related to weather and hunting pressure. Previous research has demonstrated that these are two of the primary factors affecting duck distribution during fall migration. This research has potential management implications for proactively addressing wetland conservation aimed at providing increased overwintering and spring migratory habitat. This research could also help inform future waterfowl hunting and viewing opportunities to match shifting fall migratory patterns and winter distributions.

Poster-28

Distribution of Game-Farm Mallard Release Programs Throughout the United States

Presented by: Hunter Collins (hcolli01@syr.edu)

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Mallards (Anas platyrhynchos) have been selectively bred in Europe for centuries. Game-farm mallards in the United States originate from this European stock. Since the 1920s, large numbers (e.g., ≥ 250,000) of game-farm mallards have been raised and released annually to supplement hunting opportunities across the United States. Although most game-farm mallards do not survive, some become feral, hybridize with wild mallards, and produce offspring the following spring leading to generational hybridization events. European mallards differ morphologically and behaviorally from wild mallard populations that developed in North America, and as a result, hybridization may be introducing maladaptive traits into wild populations. Current estimates of game-farm mallard inputs into wild populations are about 250,000 individuals annually, but the true magnitude of contributions that game-farm mallard release programs make towards wild mallard populations is poorly documented. As mallard populations in the eastern United States decline and hybridization of wild x game-farm mallards is increasingly apparent farther west in North America, it is essential that we refine our estimates and understanding of the spatial and temporal scale of game-farm mallard releases to identify areas with the greatest potential contact of wild with game-farm mallards. We hypothesize that current release estimates are lower than the actual number of game-farm mallards being dispersed across the United States each year. As a result, the effect that game-farm mallards are having on wild populations could be underrepresented in current literature. By conducting an extensive review of the web using standardized keywords, we aim to identify all game-farms, shooting preserves, and other facilities actively releasing mallards and overlay these data spatially with those of known wild x game-farm mallard hybridization rates. Our exercise will update mallard release estimates and further our understanding of the role that game-farm mallard introgression is having on wild mallard populations.

Poster-29

Development of an Aerial Waterfowl Survey for Northeastern Louisiana

Presented by: Victoria Drake (vdrake1@lsu.edu)

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Aerial surveys play a crucial role in monitoring North America's waterfowl populations and habitat conditions, and consistency across geographies and years allows biologists to track trends through time. The goal of this project is to redesign the northeastern portion of the Louisiana wintering waterfowl survey to align with statistically-robust transect surveys conducted in neighboring states within the Mississippi Alluvial Valley. To identify the optimal sampling method, we evaluated three transect weighting schemes: stratified random (unweighted), stratified by watershed, and stratified by expert opinion. Approximately 10% of the total sampling area was randomly selected for each survey period, adhering to all three schemes. Aerial flights, conducted by a Louisiana Department of Wildlife and Fisheries (LDWF) biologist, an LDWF contracted pilot, and myself, followed LDWF's established protocol, encompassing survey dates, speed, data recording, and flight altitude. Observers recorded waterfowl out to 250 m on both sides of the aircraft. We calculated the coefficient of variation (CV) for each sampling scheme to identify the most precise method for conducting transect surveys. We used bootstrapping to determine how the CVs would change if fewer transect lines were flown, such that the Louisiana Department of Wildlife and Fisheries can make optimal cost-benefit decisions about the extent of wintering waterfowl surveys in the future. Our initial data analysis revealed notably high CVs across all sampling schemes, with random 10% CVs ranging from 162% to 209%, watershed-based CVs ranging from 111% to 265%, and expert opinion-based CVs ranging from 136% and 260%. Such high coefficients of variation indicate that waterfowl are patchily distributed in very dense concentrations throughout the Louisiana portion of the Mississippi Alluvial Valley.

Poster-30

Application of Energetic Models for Migrating Waterfowl to Develop a Wetland Management Decision-Support Tool for the Montezuma Wetlands Complex, New York

Presented by: Emily Miller (emiller7@esf.edu)

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Migratory Bird Joint Ventures use energetic models to set habitat objectives based on waterfowl population objectives which are important for state, federal, and international cooperation to ensure stable waterfowl populations. However, methodology on “stepping-down” objectives to make local or regional management decisions is not typically applied and wetland management decision making can become subjective. How much area is needed for each wetland species is often debated and not all species have enough information on life-history traits to make objective decisions about area conserved or managed. Our goal was to develop energetic models to inform objective habitat management decisions in the Montezuma Wetland Complex (MWC), an important staging area for migratory birds. We calculated spring waterfowl-use-days (WUDs) by species using waterfowl count data of the MWC, February - April, 2012-2022. Thereafter, we used peak spring abundance by species, estimates of autumn to spring mortality, and migration curves from eBird to estimate total, autumn through spring WUDS. We then calculated waterfowl-energy-days (WED) needed to sustain these birds using published daily energy needs by species. Thereafter, we applied published food density estimates for the MWC and determined how much wetland area needed to be actively (971 kcal/ha) compared to passively (398 kcal/ha) managed to meet the energy needs of migrating waterfowl. We further investigated effects of climate changes scenarios, reductions in functional availability of foods from disturbance, and addition of supplemental crops on amounts and types of management necessary to sustain these waterfowl during their autumn and spring migration through the MWC. Managers would benefit from increased objectivity in management decisions provided by energetic models to make difficult decisions about how much area to actively manage for waterfowl, while allowing flexibility of parameter manipulation to ensure that all-bird conservation objectives are also met.

Poster-31

Advances in Weather-Related Indices of Waterfowl Abundance in the Central Flyway During Autumn-Winter

Presented by: Emily Miller (emiller7@esf.edu)

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During the annual waterfowl migration between breeding and wintering grounds, millions of birdwatchers and hunters observe and harvest waterfowl which provides diverse economic and cultural benefits. However, waterfowl distributions and timing of migration vary annually which can cause economic shifts in terms of hunter and birdwatcher participation. Projected prolonged changes in migration timing in addition to decreasing weather severity may require managers and state agencies to adjust waterfowl hunting seasons, which could impact local economies and increase waterfowl foraging and hunting pressure at mid-latitude wetlands, where 50-85% of historic wetlands have been lost in North America. Development of weather severity index models (WSI) help managers understand how a changing climate may influence waterfowl hunting and watching opportunities. However, WSI models have not been developed for larger bodied waterfowl such as geese and diving ducks, nor have WSI been developed outside of the Atlantic and Mississippi Flyways. Sixty years of biweekly waterfowl surveys conducted by Kansas Department of Wildlife provide a unique opportunity to continue development of WSI and examine potential impacts of decreasing weather severity on diving ducks and geese. I obtained available historic Movebank weather variables (mean daily temperature and snow depth) and the Kansas biweekly waterfowl surveys to examine how weather severity may influence the relative abundance of geese and diving ducks during autumn-winter, 1981 to 2020. Results will inform managers and biologists of potential decreasing autumn-winter departure dates of large-bodied waterfowl and potential economic impacts.

Poster-32

Wetlands in Working Landscapes: Maintaining Wetland Resilience in the Context of Agroecosystems and Climate Change

Presented by: Matt Dyson (matt.e.dyson@gmail.com)

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The Prairie Pothole Region (PPR) is the most productive waterfowl breeding habitat on the continent, but over the past century, these wetlands have been drained and lost for agricultural production, which has reduced the quality and quantity of wetlands on the landscape. Increasing agricultural land cover has been found to explain declines in productivity for six of the most common dabbling duck species in the PPR. Ducks require adequate food resources to hatch and fledge young. Invertebrates serve as the primary food source for most dabbling duck species and are critical during egg production, incubation, and brood-rearing. Invertebrate communities are dynamic and are influenced by wetland permanence and water chemistry, vegetation communities, predators, and water quality associated with agricultural land use. Agrochemicals, including fertilizer, insecticides, pesticides, and fungicides, are used to enhance crop productivity, mitigate weeds, eliminate pests, and control disease. We hypothesize that agricultural land use, including the application of agrochemicals, is affecting forage availability for waterfowl and hence, reducing duck productivity in the PPR. To test this hypothesis, we are evaluating wetlands across an agricultural gradient to understand how agricultural land use affects wetland water quality, invertebrate abundance and community composition, and ultimately their ability to support waterfowl pairs and broods. We completed a pilot season in 2023 studying 20 wetland basins across two quarter sections, one of high agricultural land cover and one of low agricultural landcover. We will present preliminary results from our pilot season, including optimization of sampling invertebrates using traditional sweep samples and environmental genomics approaches comparing environment DNA sampling and bulk tissue high throughput sequencing of sweep samples. We are quantifying pair and brood abundance using drones. We will also explore preliminary correlations between wetland water quality and agrochemical presence and concentration with invertebrate and waterfowl abundance. Our work will improve our understanding of the influence of agricultural land use and water quality on wetlands and their ability to support sustainable populations of waterfowl and other wetland dependent species in the PPR.

Poster-33

What's a Picture Really Worth? Validating the Use of Camera Traps to Estimate Waterfowl Productivity

Presented by: Matt Dyson (matt.e.dyson@gmail.com)

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Estimating waterfowl productivity is essential for harvest management and conservation decision making. Traditional methods for estimating productivity, such as ground-based pair and brood counts, are labour intensive and limited to a single or few points in time. As a result, there are limits to the number of wetlands that can be assessed for productivity. Alternatively, camera traps can monitor waterfowl populations continuously throughout the pair and brood periods at many wetlands simultaneously. While camera traps have seen a dramatic increase in their use to monitor wildlife, it is unknown whether the data collected from camera traps is comparable to ground-based surveys. The objective of our study was to compare ground-based pair and brood surveys to camera trap surveys estimating relative waterfowl abundance and productivity at prairie wetlands. We deployed cameras and conducted concurrent pair and brood surveys at 20 basins in the aspen parkland ecoregion of southwestern Manitoba. We programmed cameras to take timelapse images at 10 min intervals during daylight hours. Our results will determine whether pair and brood abundance and waterfowl species richness were positively correlated between ground-based surveys and camera trap surveys. In addition, we are investigating the difference in detection probability between the two methods and will make recommendations regarding the timing and sampling period for camera traps. Our results will provide a framework for using camera traps to monitor breeding waterfowl at a wider temporal and spatial range of wetlands.

Poster-34

Eggshell Strength in Three Cavity-Nesting Ducks in Mississippi

Presented by: Hunter Mentges (hem357@msstate.edu)

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Wood ducks (Aix sponsa), hooded mergansers (Lophodytes cucullatus), and black-bellied whistling ducks (Dendrocygna autumnalis) are secondary cavity-nesting duck species with geographical overlap in the southeastern United States. Interspecific clutches are common among these species; eggs accumulate in nests from parasitic laying, and strife between females may occur, all of which potentially subject eggs to breakage. Understanding the durability of eggs of these species is important for explaining variation in nest and egg hatching success. Based on egg dynamics in these species, we predicted that eggshell breaking strength (EBS: eggshells most resistant to breakage) would be greatest for hooded merganser relative to the other species examined. We collected a total of 67 fresh eggs of all three species from nest boxes at two sites in Mississippi in spring–summer 2021. We measured eggshell strength using an Instron Universal Testing Machine (Model 3345; Instron Inc., Norwood, MA) and eggshell thickness using a micrometer (Ames, IA). We measured EBS (Newtons) at the equator of all eggs. We applied analysis of variance followed by a Tukey's pairwise comparison to test for differences in eggshell strength among species. Mean EBS differed among all species ($P < 0.001$) and was greatest in hooded merganser, followed by black-bellied whistling duck, and wood duck. MeanEBS was 120.05 (SD = 12.03, n = 7) for hooded merganser, 52.44 (SD =10.04, n = 30) for black-bellied whistling duck, and 32.95 (SD =3.90, n = 30) for wood duck. Our results are preliminary but eggs of hooded merganser had the highest EBS, likely attributed to greater eggshell thickness among these species. Further analyses will explore if eggshell strength correlates inversely with egg breakage, investigate the mineral composition of eggshells for the three species, and how eggshell strength and thickness vary with latititude, species, and biotic and abiotic conditions at nest sites.

Poster-35

Brownie-Lincoln Abundance Estimation in a Bayesian Estimation Framework

Presented by: Cody Deane (cdeane2@alaska.edu)

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Lincoln's method of estimating abundance relies on direct recoveries to meet the assumption of demographic closure. If recently banded adult waterfowl experience a series of life-history events that cause them to experience different harvest vulnerability relative to the rest of a population, then Lincoln estimates from direct recoveries may be biased. We evaluate a Brownie-Lincoln abundance estimator that combines Lincoln's method with harvest probabilities estimated by band-recovery models. Using a Bayesian estimation framework, we also present a new method for incorporating reporting probabilities into the likelihood of band-recovery models so that these models estimate harvest probabilities instead of recovery probabilities. With our Brownie-Lincoln modeling approach, we compared annual abundance estimates of midcontinent mallards from 1979–2019 derived from direct or indirect harvest probabilities. We found direct and indirect harvest probabilities estimated for adult males varied little within years. Indirect harvest probabilities of adult females tended be lower than direct harvest probabilities and this gap has grown in recent years. As such, abundance estimates for adult males did not depend on recovery type, while abundance estimates for adult females did. Adult female abundance based on indirect recoveries was higher than estimates based on direct recoveries and after 2010, there was little overlap between the 95% credible intervals of these annual estimates of adult females. Adult sex ratios based on direct recoveries suggest 3.0–4.5 males for every female after 2010, but this ratio was 1.8–3.0 males for every female when based on indirect recoveries. Our results indicate possible sampling variation in band-recovery data should be assessed with modeling approaches that assess differences in harvest susceptibility of just-banded waterfowl versus those indirectly harvested more than one year after being banded.

Poster-36

Atlas of Sea Duck Key Habitat Sites in North America

Presented by: Kate Martin (kate_martin@fws.gov)

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Available evidence suggests that several sea duck populations in North America are declining or below historical levels of abundance, and their habitats are susceptible to the impacts of climate change and other anthropogenic factors. The Sea Duck Joint Venture (SDJV) is a conservation partnership formed under the North American Waterfowl Management Plan to advance knowledge about sea ducks and improve their conservation and management. Since 2001, SDJV partners have completed surveys and studies that provided information on the distri¬bution and abundance of sea ducks throughout the annual cycle. Using this information and other available sources, the SDJV developed the Sea Duck Key Habitat Sites Atlas which describes 85 sites throughout North America that constitute important sea duck habitats. Criteria for site inclusion were chosen to highlight habitats most critical to sea ducks during at least one season. Sites had to meet the following minimum criteria: The area supports at least 5% of the continental population of a sea duck species, or the area supports a total of at least 20,000 sea ducks during any season, and the density of sea ducks within the area is at least 10 birds per kilometer. Narrative descriptions in the Atlas include a synopsis of sea duck abundance and impor¬tance of the site to sea ducks, as well as sensitivities or potential conflicts that may impact sea ducks or their habitats. The Atlas is intended to heighten awareness of valuable sea duck habitats, aid in prioritizing habitat conservation and protection efforts such as oil spill prevention and response and provide information for environmental assessments. The SDJV intends to regularly update the Atlas with new information as it becomes available. The Atlas and associated data products can be found at seaduckjv.org.

Poster-37

Environmental Attributes and Wetland Management Influence Seed Abundance in Seasonal Wetlands

Presented by: Dan Smith (dsmith@ducks.org)

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The number of wintering waterfowl within the Suisun Marsh, California has dropped below CVJV population objectives. A recent evaluation of waterfowl food resources found that seed abundance was less than half of what was predicted to be available in seasonal wetlands. Previous research suggests that there are relationships between the occurrence of wetland plants (which produce the majority of seeds that waterfowl consume) and some wetland management actions, but there have been no direct evaluations of the environmental attributes and management practices that might influence seed abundance. We collected and analyzed 730 soil cores from 71 managed wetlands in the Suisun Marsh to test the hypotheses that seed abundance would be correlated with: (1) region (habitat zone), (2) salinity, (3) wetland management infrastructure, (4) soil type, (5) disking, and (6) overall management intensity. The occurrence of several plant species was correlated with salinity, management intensity, and disking. The best predictor of total seed abundance was habitat zone, which is defined by shared physical factors known to impact vegetation growth and production. Our results indicate that management can influence the occurrence and composition of important food plant species, but location (region) had the greatest influence on the overall abundance of seeds in these managed wetlands. These regional differences in seed abundance have implications for tidal restoration efforts because the loss of seasonal wetland acreage within more productive regions of Suisun Marsh could have a disproportionate impact on total food availability. Moreover, our data suggest that management practices intend to enhance wetland conditions and increase seed abundance may be limited by environmental conditions.

Poster-38

Use of Thermal-Energetic Environments by Female Northern Pintails Under Current and Future Climatic Conditions

Presented by: Joseph McGovern (joseph.mcgovern@students.tamuk.edu)

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During spring migration, waterfowl must balance time and energy in order to optimize their reproductive success. Energy spent on thermoregulation may carry a significant cost, and early-migrating birds may be incurring greater costs due to encountering colder temperatures. Under climate change, temperature may become a more significant factor in migration energetics, particularly as temperatures become more variable with increasing incidence of extreme weather events. Intraspecific variation in strategies for balancing thermoregulatory costs may highlight adaptations in response to novel thermal landscapes predicted under climate change scenarios. The northern pintail (Anas acuta) is one of the earliest arrivals to breed in the Prairie Pothole Region, and thus is likely experiencing eco-physiological costs with regards to cold stress. We aim to model how female northern pintails use thermal-energetic environments in central and western North America during spring migration, and how over-wintering region and age of the birds influences intraspecific variation in eco-physiological performance. We then will predict changes to the thermal-energetic landscape resulting from projected climate change in these areas, and how pintail migration may be affected.
Female pintails wintering in Texas, Louisiana, New Mexico, Arizona, and California, USA, were fitted with GPS transmitters 2019-2023. We will use microclimate model predictions linking air temperature to existence metabolism to define available thermal-energetic environments for pintails. We will model individual use of these environments using a conditional resource selection function. We will then characterize individual variation in this selection, and assess demographic and regional drivers of this variation using general linear-mixed models. Finally, we will model changes in thermal-energetic environments using projected climate change predictions and how this may affect pintail spring migration.

Poster-39

Changes in Survival of Upland Duck Nests in Relation to Long-Term System Change in the US PPR

Presented by: Dave Brandt (dbrandt@usgs.gov)

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Prairie-nesting duck populations have experienced considerable fluctuations over the past 7 decades in North America. Population estimates for many species recently reached all-time highs since surveys began in the 1950s. Waterfowl researchers have studied breeding ecology and productivity of ducks by locating and monitoring the fate of upland duck nests to estimate nest survival, a vital rate known to have high spatiotemporal variation and a large effect on population growth rate in these species. Past work has suggested reduction in nest survival from the 1930s to mid-1990s, with many estimates below that which could sustain positive population growth. Yet, some studies in the past two decades have reported nest survival estimates higher or considerably higher than found in the past (e.g., ~40%). We implemented contemporary nest survival estimation techniques to determine if a pattern of higher nest survival were spatially isolated or widespread. We also integrated long-term nest fate data from >90,000 nests monitored during 1970-2022 with similar data sources (e.g., brood surveys) to test hypotheses regarding potentially influential factors that have changed in the U.S. PPR. Results of these analyses will provide insight into how nest survival has varied with time and with long-term changes in perennial cover, drought and deluge cycles, and predator community composition. Finally, we will provide commentary on how changes in reproductive output of ducks may have influenced regional breeding waterfowl populations.

Poster-40

The Effects of Ventilating Wood Duck Nest Boxes on Box Microclimate, Box Use, and Nest Success

Presented by: Tenaya Russell (tmrussell@ucdavis.edu)

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California's Sacramento Valley is a key nesting area for Wood Ducks (Aix sponsa) in the Pacific population. We have monitored multiple sites with differing densities of Wood Duck nest boxes and varied habitat types in the Sacramento Valley for over twenty years. Through these studies, we have identified an alarming trend - the percentage of eggs that successfully hatch has been declining, reaching an all-time low in 2021 at 22%. Many eggs appear to develop normally, but then fail close to hatch, often during summer heat waves. Ventilating passerine nest boxes in hot climates is a common method to moderate internal box temperatures. However, the effectiveness of nest box ventilation or its consequences for nest box inhabitants have not been investigated thoroughly. We monitored temperature and Wood Duck nests in ventilated and non-ventilated paired boxes. To ventilate boxes, we drilled three one-inch holes on either side and lifted the roof one inch using felt pads at each corner. We installed iButtons to monitor the temperature inside and outside of each box. In boxes with active nests, we also recorded incubation temperatures using an iButton attached to an artificial egg. We hypothesized that ventilated boxes would have a cooler daily average temperature and a greater daily range of temperatures than non-ventilated boxes. We also hypothesized that ventilation would not affect the probability of a hen using the box, increase the likelihood of nest success, and improve the percentage of eggs hatched in successful nests. Preliminary analyses do not support these hypotheses. Females appear to be less likely to use ventilated boxes and nests were more likely to fail or have lower hatch success in ventilated boxes. We discuss possible reasons for these counter-intuitive results and consider the implications of using nest box ventilation as a management tool.

Poster-41

Working Lands Programs as a Means to Conserve Waterfowl Habitat

Presented by: Kyle Kuechle (kkuechle@ducks.org)

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Waterfowl population levels are primarily regulated by their productivity on the breeding grounds with the Prairie Pothole Region (PPR) of the US and Canada representing one of the most important areas for said productivity. Waterfowl habitat availability in this region continues to decline with estimated grassland and wetland loss rates having been as high as 5 and 0.57% annually, respectively.
Wetland habitat loss and degradation in the region can happen directly (drainage, consolidation, filling, etc.) or indirectly where wetlands receive agricultural pollutants (excess nutrients, sediments, pesticides) to the extent they may no longer provide quality waterfowl habitat. Conservation organizations have sought to stem these direct and indirect losses of habitat in the region through a variety of programs. Perpetual easements remain a great option to avoid the direct loss of habitat in the region, but these are often not the best fit with some agricultural operations. To better accommodate stakeholder needs, Ducks Unlimited (DU) and project partners have protected wetlands with working lands programs on term-limited contracts. Often these working lands programs include cover crops, improved grazing infrastructure, and integrating livestock on cropland targeted at parcels with high numbers of seasonal and temporary potholes. Here we analyze these working lands programs to evaluate rate of adoption across the US PPR, the number of wetlands protected through these actions, and the number of wetlands enrolled that were at-risk of conversion (i.e. not previously protected under perpetual easement). Further, we present results of ongoing wetland water quality (e.g. nitrogen and phosphorus concentration of wetland water) research to determine habitat suitability of wetlands enrolled in working lands programs. We anticipate these results will help shape DU’s and other conservation organization’s conservation programs in the future.

Poster-42

Estimating Apparent Survival Probabilities of Black-Bellied Whistling Ducks

Presented by: Paul Link (plink@wlf.la.gov)

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The Black-bellied Whistling Duck (BBWD) is a Neotropical duck found only in the western hemisphere. It is more arboreal than other whistling-ducks; it nests primarily in natural tree cavities and readily utilizes artificial nest boxes, but also commonly ground nests. In North America, this species historically bred mainly along Mexico and south Texas coasts. However, their range began expanding northward mid-20th century, with sightings in Arizona, Louisiana, and Florida by the 1960s. They are a game species with liberal regulations; however, they are lightly harvested because of their nocturnal nature. Most congregate in urban or industrial areas during fall and winter where they cannot be harvested or easily surveyed, which makes estimating vital rates such as survival and harvest probabilities more challenging than for most other waterfowl species. A Cormack Jolly Seber model is appropriate for non-game or lightly harvested species such as BBWD with few dead recoveries. This model uses bandings and live recaptures of banded birds (usually by the same or another bander) to estimate “apparent” survival. We estimated adult BBWD apparent annual survival estimates of BBWD banded Feb-May in south Louisiana, using several Cormack Jolly Seber models (including sex, year, banding area, and interactions). Annual apparent survival estimates were highly variable and imprecise. Sex*banding area estimates ranged from 0.38 to 0.51. Apparent survival differs from the annual survival derived from the Brownie dead recoveries model in that it assumes no permanent emigration from the study area. Thus, to the degree that this assumption is violated, apparent survival will be biased low relative to survival from Brownie models, and can be considered a minimum annual survival probability. We suspect this is the case for BBWD, and are currently pursuing the use live and dead recoveries to obtain unbiased estimates of annual survival.

Poster-43

Quantifying Neonicotinoid Concentrations and Toxicity Thresholds in Aquatic Macroinvertebrates: Implications for Wetland-Dependent Wildlife

Presented by: Corinne Sweeney (cmsy95@missouri.edu)

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Neonicotinoid application as agricultural pesticides has increased rapidly since the early 2000s when treated seeds and foliar sprays for crops became commercially available. However, the widespread and prophylactic use of neonicotinoid seed treatments has caused concern due to lethal and sublethal effects on non-target species. High leachability and water solubility contribute to the mobility of neonicotinoids from agroecosystems into non-target aquatic ecosystems. Aquatic invertebrates that inhabit freshwater systems and provide important ecosystem services may be exposed to neonicotinoids through water run-off or accumulation in sediments over multiple years of seed application. Lethal and sublethal effects such as decreased growth and delayed time to emergence have been observed in laboratory aquatic insect bioassays. Additionally, changes in aquatic invertebrate community structures and abundance associated with neonicotinoid concentrations have been reported in both field and mesocosm studies. Recent research reported neonicotinoid concentrations in Missouri wetland sediments were an order of magnitude greater than aqueous concentrations observed in the same wetlands. Although neonicotinoid benchmark concentrations for aquatic insects have been determined in water, sediment toxicity thresholds have not yet been established and thus, the implications of contaminated sediment for aquatic insects in freshwater systems are largely unknown. To address this knowledge gap, we will present data detailing the persistence and bioavailability of neonicotinoid-associated sediments using wetland sediments of differing organic carbon content. Next, to quantify conservative toxicity thresholds for sediment, we are conducting chronic sediment toxicity tests using the established model species, Chironomus dilutus as well as the more sensitive mayfly species, Neocloeon triangulifer. Finally, we are quantifying neonicotinoid concentrations in aquatic macroinvertebrates collected in Missouri wetlands to evaluate potential for bioaccumulation to waterfowl and other wetland-dependent wildlife. Combined results from our field and laboratory studies will help establish sediment toxicity thresholds for aquatic macroinvertebrates and increase understanding of neonicotinoid on wetland food webs.

Poster-44

Duck Use of Wastewater Treatment Lagoons During the Non-Breeding Season in Oregon, Usa

Presented by: Sarah Jayne Swann (swanns@oregonstate.edu)

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Loss of natural wetlands to agriculture and development or because of reduced water supply caused by climate change or changes in water allocation among competing interests can influence regional carrying capacity for wintering ducks. In part, ducks may mitigate such changes by adapting to use anthropogenically created habitats like reservoirs and wastewater treatment ponds (WWTPs), which are more predictably available. Use of reservoirs has been studied, but use of WWTPs has not been quantified. Using Oregon as a case study, we used eBird data to quantify duck use of WWTPs. We identified 166 water treatment sites across Oregon, of which 44 had outdoor ponds with eBird data available. We subsampled eBird data for these sites to quantify species composition and abundance and investigate how data varied across seasons. Data indicate that at least 27 species of ducks use WWTPs seasonally, with a subset using sites year-round. Species composition varied by season and WWTPs supported considerable numbers of birds during the non-breeding season. In some cases, the abundance and distribution of WWTPs on the landscape may contribute to altered migratory patterns in some species by providing a thermal refuge further north than natural conditions allow. Wastewater has the potential to harm wildlife if contaminants such as heavy metals and synthetic chemical compounds that can act as endocrine disruptors are present, though effects on behavior and health are better studied in other taxa. The infrastructure of a WWTP in Australia has been considered as a contributing factor to duck mortalities due to entrapment and drowning, suggesting multiple mechanisms by which WWTPs may pose potential risks to ducks. Given the large number of such sites in the U.S., a more thorough review of duck use of WWTPs would expand our understanding of how this habitat contributes to ducks wintering in the United States.

Poster-45

Comparing Diet and Body Condition of Male and Female Dabbling Ducks

Presented by: Jacqueline Satter (jmsatter@ucdavis.edu)

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Differences between the sexes are not commonly studied or considered in current waterfowl management contexts. A multi-species evaluation of dietary trends and corresponding body condition between the sexes would better inform our understanding of how their nutritional requirements differ, how they overlap in or compete for resources, and how these patterns change over winter. We collected 691 individuals of 7 species over two 6-month winter seasons, analyzed sorted esophageal contents from each bird and then homogenized the specimens and undertook proximate analysis of lipid content per dry mass to provide accurate estimates of body condition. We found that body condition varied among species and over the winter, but these patterns differed among species. We also found that differences between male and females of the same species differed most significantly between Green-winged Teal, American Wigeon, and Gadwall. Diets varied among species as well, most significantly between Northern Shoveler, American Wigeon, Gadwall, and everyone else (Mallard, Northern Pintail, and Green-winged Teal). Mallard, Northern Pintail, and Green-winged Teal had similar diet contents but the order of their most prevalent food items varied. Most surprisingly, there was significant variation between male and female diets of all species except Northern Shoveler. (Cinnamon teal removed for inadequate sample size.) A comprehensive assessment of diet preferences of the sexes will help us better manage winter food and habitat, while a better grasp on variation between body condition of the sexes will help us understand how responses to seasonal resource fluctuations vary with their respective demands. Finally, by examining the relationship between diet and body condition we can better assess how the sexes differ in their cross-seasonal resource use and allocation, given that body condition is considered an important predictor of migration and subsequent breeding success.

Poster-46

Measuring Efficacy of Artificial Nesting Structures in Breeding Mallard Populations of Northern California

Presented by: Evan Yunker (evan.yunker@oregonstate.edu)

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Artificial nesting structures have been used successfully to improve nest success for several species of ducks in North America. In the Prairie Pothole Region (PPR), horizontal nesting tubes made of wire fencing and straw (called hen houses) have been readily used and are known to increase nest success rates for mallards (Anas platyrhynchos). However, they have been used in limited capacity elsewhere in North America. We deployed 200 hen house nesting structures in three regions of northern California (Suisun Marsh, Butte Sink, and Northeastern CA/Great Basin) in 2023 on private and public wetlands to estimate their use by mallards, estimate nest success, and study the factors that influence use. Hen houses were placed among a variety of permanent and semi-permanent wetlands at varying heights, densities, and water depths. Four species used eight out of 200 hen houses; three mallards (Anas platyrhynchos), two great horned owls (Bubo virginianus), two barn swallows (Hirundo rustica), and one wood duck (Aix sponsa). Duck nest success was 100%. Data collection and monitoring of hen houses will continue for another breeding season.

Poster-47

Predicting Waterfowl Productivity and Abundance Using Brood Pair Ratios

Presented by: Catrina Terry (cterry@ducks.org)

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Management and habitat conservation decisions for waterfowl in the Prairie Pothole Region are largely informed by pair distributions and nesting success. However, habitat suitable for breeding duck pairs and nesting hens may not be representative of what is available for broods later in the breeding season. Further, nesting studies are time and labor intensive, so estimates of annual reproductive success at scales relevant to management are often not feasible. We use an alternative index of waterfowl productivity – brood-pair ratios – to examine differences across two management regimes. Using recently developed unmanned aerial vehicle brood-survey methods we conducted two rounds of pair surveys starting in late April 2023 and concluded in late May 2023, recording breeding pairs and social groups. In mid-June to mid-July 2023, we conducted two rounds of brood surveys. In addition to brood surveys, we collected information on emergent vegetation, wetland inundation, size, and cover class. We analyzed our results with the five most common prairie breeding species, estimated brood abundance and habitat use by hierarchical abundance models and derived BPR by brood abundance divided by total pairs recorded on each wetland.

Poster-48

Impacts of Refuge Connectivity on Waterfowl Distribution and Hunting Opportunities in Western Tennessee

Presented by: Cory Highway (chighway42@tntech.edu)

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Wintering waterfowl exploit heterogeneously distributed resources across landscapes congested with anthropogenic predation risk. Unhunted lands on public properties serve as refuge networks for migrating and wintering waterfowl, which are assumed to facilitate movement between resource patches. However, ongoing research suggests current refuges are too distant to be connected and most areas between refuges have low waterfowl abundance. In other words, waterfowl distributions are heavily concentrated to areas within close proximity to safety and little movement exists between these refuge nodes. We have worked with private landowners to introduce 30-120 ha rest areas across western Tennessee during 2022-2025 in hopes of increasing connectivity and balancing waterfowl distributions. Concurrently, we are deploying ~200 GPS transmitters on mallards annually to examine landscape utilization changes after rest area establishment. Additionally, we are using unmanned aerial surveys to quantify waterfowl usage of private lands. We are using autonomous recorders to quantify gunshots and identify if implementation of rest areas changes hunter opportunity. Overall, our research will provide a framework to understand if and under what conditions strategic placement of private land rest areas can benefit wintering waterfowl and waterfowl hunters.

Poster-49

Fowl Play in High Gear: Harnessing the Power of Intensive Cattle Grazing for Waterfowl Production in North Dakota

Presented by: Taylor Linder (taylor.linder@ndus.edu)

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The Prairie Pothole Region is home to millions of acres of grassland habitats for nesting waterfowl, and in many cases, these grasslands fall within private lands often used for livestock production. In North Dakota, nearly 74% of grasslands are used for cattle grazing and appear to heavily coincide with some of the highest densities of breeding waterfowl populations. While previous research has explored the effects of longer rotational grazing (LRG) methods on waterfowl reproduction, only a few studies have empirically investigated the effects of intensive cattle grazing, specifically high intensity, short duration (HISD) cattle grazing, on upland nesting waterfowl. Our study was conducted along the Missouri Coteau in central North Dakota, where duck densities can average upwards of 100 duck pairs per square mile. Using a rope dragging method, we searched eight plots, four HISD and four LRG, from 2021 – 2023. We found a total of 126 duck nests; 22 in 2021 and 52 in 2022 and 2023. In 2021 and 2023, we found nearly equal numbers of waterfowl nests on HISD and LRG plots; however, in 2022 we found 3 times more duck nests on HISD sites than LRG sites. Despite these trends, apparent nest success was nearly the same between the two grazing methods. We hypothesized that the higher cattle densities in HISD systems would result in higher trampling of nests, however, our data suggests that trampling rates of duck nests are very low (<2%). From a rancher perspective, HISD is often perceived to have increased resiliency that facilitates forage regeneration in addition to providing habitat for nesting waterfowl. Going forward, managers should consider HISD as a viable alternative grazing method that provides dual outcomes for ranchers and their cattle, as well as upland nesting waterfowl.

Poster-50

University Waterfowl Programs: A Resource at Risk?

Presented by: Diane Eggeman (deggeman@ducks.org)

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Despite knowledge that waterfowl are ecologically, environmentally, and economically important worldwide, university-based programs that train waterfowl specialists in North America have declined since the 1970s (Kaminski 2002, 2013; Wildlife Society Bulletin, Wildlife Professional, respectively). The North American Waterfowl Professional Education Plan (NAWPEP), a subunit of the North American Waterfowl Management Plan (NAWMP; https://nawmp.org/document/north-american-waterfowl-professional-education-plan-2020), has worked since 2020 to bolster future availability of waterfowl specialists for employers. During summer 2023, the NAWPEP steering committee distributed an online survey to 56 university department heads or chairs in the United States and Canada to update information on the status of university-based waterfowl programs. These institutions were identified by the NAWPEP steering committee as ones believed to currently or previously have a faculty member(s) who conducted waterfowl research or teaching. Administrators from 40 institutions responded (71%), suggesting data reliability. Thirty-two (80%) of the 40 respondents reported having one or more waterfowl faculty members for a total of 42 current waterfowl faculty. By comparison, 65% of respondents in a 2013 survey reported at least one waterfowl faculty member and a total of 35. Indeed, the increase in waterfowl faculty members and currently endowed waterfowl and wetland positions (n = 13) are fulfilling objectives of NAWPEP's strategic plan and testimony to the importance of these positions for training future waterfowl professionals. Nonetheless, for 28 (67%) of the 42 positions reported, respondents indicated a low to medium likelihood that another person with waterfowl expertise would be hired if the current specialist departed, indicating those programs remain at risk. Given a continuing aging faculty of waterfowl specialists, the risk of losing these positions remains real and justifies NAWPEP and partners' efforts to

sustain existing positions and advocate for additional endowed university positions to support science and conservation priorities of the NAWMP community.

Poster-51

Winter Group Feeding Behavior of Northern Shovelers: Implications for Waterbird Diversity and Conservation in Colorado

Presented by: Drew Bender (dbender6@msudenver.edu)

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Winter Group Feeding Behavior of Northern Shovelers: Implications for Waterbird Diversity and Conservation in Colorado.
Northern Shovelers (Spatula clypeata, NSHO) are a dabbling duck found throughout the Northern Hemisphere. These ducks have been observed performing a type of group aggregate feeding behavior in the winter where large numbers of ducks move in a circular pattern to concentrate food. Our objectives were to determine if NSHOs show site fidelity for winter group feeding in the Denver Metro Area and if there is an association with NSHO feeding and other waterbirds. We hypothesize that NSHOs will consistently feed in large groups at preferred sites throughout the winter and that we will find greater species diversity of other waterbirds at these preferred habitats. We collected bird count data for 65 waterbodies in the Denver Metro Area twice monthly from October 2022 through April 2023. We compared NSHO preferred and non-preferred feeding habitat for waterbird abundance, species richness and species diversity (Simpson's Diversity Index). Statistical significance was determined using an unpaired Student's t-test. Of the 65 waterbodies, 17% had consistent NSHO group feeding. Overall, we found statistically higher abundance ($\bar{x}$= 427.95±678.99, t=4.40, p<0.01, df=128), species richness ($\bar{x}$= 5.04±3.50, t= 3.98, p<0.01, df= 132), and diversity ($\bar{x}$= 0.41±0.26, t= 2.29, p= 0.02, df= 127) of avian species at preferred waterbodies compared to non-preferred waterbodies (respectively: $\bar{x}$=72.51±227.73, $\bar{x}$ =2.46±2.72, $\bar{x}$ =0.25±0.31). Furthermore, we noted in our observations that diving ducks (81.25%) interacted more with NSHO feeding groups than dabbling ducks (18.75%). The diving duck association with NSHO feeding circles possibly suggests that large feeding circles may create a vortex under the water giving NSHO access to the same resources as diving ducks. NSHO preferred feeding habitat is indicative of important habitat for other waterbirds and understanding this preference will help guide future management decisions in a changing landscape.

Poster-52

Social Associations of the Endangered Koloa Maoli and the Role of Plumage and Genetic Relatedness

Presented by: Keerthipriya Palanive

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The koloa maoli (Anas wyvilliana) is the last remaining endemic duck species found in the main islands of Hawai'i. The biggest threats facing this species are hybridization with feral mallards, and avian botulism outbreaks. Currently, the island of Kaua'i contains the largest population of genetically pure koloa, which are largely restricted to the island. Little is known about social relationships in sedentary bird populations, but information on social associations in koloa might shed light on preferences for or against feral mallards and hybrids, and inform planned translocation efforts of koloa to other islands. Additionally, other non-migratory species of island birds, including some in Hawaii, show microgeographic spatial genetic structuring, in which individuals found close together are more related than those found farther apart. Spatial genetic structure is a potential liability for maintaining koloa genetic diversity, if highly localized outbreaks of botulism remove entire lineages of genetic diversity. From 2010-2015, koloa were captured, banded, and recaptured on Kaua'i. We used the adult capture data to infer social associations from trap co-occurrence. We constructed social networks, and examined whether koloa have preferential associations based on plumage traits (monochromatic 'koloa-like' vs dichromatic 'mallard-like') or genetic relatedness (for a subset of genotyped ducks). We also used genetic data to look for evidence of female and/or male microgeographic structure the koloa. While we did find persistent social associations in adult koloa, they were not apparently influenced by plumage traits or genetic relatedness. Importantly, we found no spatial patterns of relatedness within the largest refuge, suggesting that localized botulism outbreaks will not remove correlated genetic diversity in this endangered endemic.

Poster-53

A Predictive Model of True Metabolizable Energy of Waterfowl Foods from Food Characteristics

Presented by: Rob Blenk (rb366@humboldt.edu)

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Estimating landscape energetic carrying capacity is an essential part of winter waterfowl population management, but this practice is dependent on accurate estimates of relevant environmental parameters. In addition to the amount of food on the landscape, the energetic content of that food (chiefly in terms of caloric density) is necessary in the calculation of total available energy. Further, waterfowl are imperfect digesters of food, and thus estimates of true metabolizable energy (TME) rather than gross calorific content are necessary to accurately estimate the value of specific foods. Despite this, empirical estimates of TME values are only available for a small portion of the foods consumed by waterfowl. Techniques for estimating TME, traditionally involving experimental feeding and restraint of captive birds, collection of excreta, and laboratory calorimetry, can be costly and time-intensive. We performed a literature search for all available empirical estimates of TME and the nutritional contents of foods to generate a predictive model capable of providing estimates of TME from nutritional characteristics of waterfowl foodstuffs. Based on analysis of these existing values, we find that percent crude fiber content (likely representative of food ‘hardness’) is the strongest predictor of TME, followed by gross calorific content, protein content, and fat content. These relationships are particularly strong when analysis is limited to seeds. Depending on the objectives, our approach provides a useful tool for more accurately assessing habitat carrying capacity for wintering waterfowl.

Poster-54

Insights from the Stillaguamish River Delta, Washington: Building Partnerships Through Mallard Banding

Presented by: Kyle Spragens (kyle.spragens@dfw.wa.gov)

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Beginning in 2019, Washington Department of Fish and Wildlife – Waterfowl Section and the Stillaguamish Tribe of Indians – Natural Resources Department partnered to expand pre-season duck banding targeting mallards in the North Puget Lowlands of western Washington. Initial interests were to expand banding capacity and representative mallard banding into a portion of the state that harbors consistent breeding pairs encountered during spring aerial surveys, and to document connections of the Stillaguamish River Delta and Port Susan Bay region to other regions of the Pacific Flyway. However, this partnership has led to exploring deeper ecological and management-relevant questions in this intertidal-agricultural landscape. The authors will present preliminary band recovery data from four summers of cooperative banding and highlight recent expansion into using MOTUS network and GPS-GSM marking technologies to pilot collecting movement and habitat use data in this highly dynamic and habitat-diverse landscape.

Poster-55

Mallard Ecology in the Columbia Basin Washington: Embarking on New Insights

Presented by: Kyle Spragens (kyle.spragens@dfw.wa.gov)

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The Columbia Basin region of Washington state has long been a stronghold for wintering mallards in the Pacific Flyway. Mallard are consistently the number one duck in annual harvest, with nearly 50% of total duck harvest comprised of mallards. However, embarrassingly little exists in the literature documenting the use of wetlands by mallards in this vast region. Additionally, recent insights have suggested that harvest rates of Washington-banded mallards are consistently above the expected harvest rate value for the Pacific Flyway. Over the past three years, Washington Department of Fish and Wildlife has been ramping up pre-season mallard banding in eastern Washington, including expanding banding operations into regions that have not traditionally been covered consistently. Starting in summer 2023, marking of mallards using GPS-GSM technology has kickstarted the initial phase of a planned long-term study investigating more details of this important species in Washington to improve our management and understanding of limitations and considerations related to nesting and non-breeding seasons in the Columbia Basin. This presents an excellent opportunity for graduate projects and hands-on field work; please come talk to the authors if you have a passion to pursue applied waterfowl management!

Poster-56

Evaluating the Effectiveness of Gull Control as a Management Tool for Increasing Common Eider Duckling Survival

Presented by: Dustin Meattey (dustin.meattey@briwildlife.org)

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Duckling survival has been identified as a significant limiting factor for a sustainable population of the American common eider. Although periodic boom/bust cycles in duckling survival and breeding success of females have helped maintain common eider populations in the past, evidence suggests that fewer and/or less frequent years of increased production have occurred within the Gulf of Maine which is necessary for maintaining the eider population. In 2016, a collaborative project among Biodiversity Research Institute, USFWS, Maine Department of Inland Fisheries and Wildlife, and USGS, initiated a pilot study to test the feasibility of marking female eiders with nasal tags and VHF radios and tracking individual broods to determine duckling survival at an important nesting colony in Casco Bay, Maine. We continued to nasal mark and radio tag hens during the 2017-23 seasons and collected additional apparent duckling survival rates during the 2018-23 seasons.

In 2021 we implemented active gull control efforts at the focal eider nesting colony, targeting great black-backed gulls, to evaluate the effectiveness of gull control as a management tool to increase eider duckling survival by comparing apparent survival rates during the pre-treatment and treatment periods. During the 2021 and 2022 seasons, we baited a total of 346 gull nests with DRC 1339, while in 2023 we switched methods to targeted shooting. During the same period (2021-23), we tagged and tracked an additional 60 adult hen eiders to obtain weekly brood counts. We documented a marked increase in eider ducklings surviving to fledge in 2021 compared to 2016-2020 seasons (42% apparent survival in 2021 compared to a previous high of 22%). The 2022 season resulted in extremely low apparent duckling survival (1%), potentially related to especially high rates of HPAI circulating in the environment, providing an indication of the potential severity of HPAI to common eider duckling survival. Survival in 2023 rebounded to 30%, however, we documented 52% apparent survival at a nearby control site with fewer gulls than at the treatment colony.

Poster-57

Rapid Assessment Models with Standardized Applications to Support Bioenergetic Modeling

Presented by: Cole Howard (choward43@tntech.edu)

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Migratory waterfowl rely on managed natural and agricultural vegetation communities to meet energetic demands during non-breeding periods. The quantity and quality of these vegetation communities across the landscape informs bioenergetic models and regional planning for wintering waterfowl, but also requires annual resource monitoring data. Likewise, monitoring forage biomass relative to management actions also feeds into an adaptive management framework to identify preferential practices. We developed standardized protocols and survey applications for rapid yield assessment of important waterfowl forages including moist-soil vegetation, unharvested rice, and unharvested corn. Our standardized applications allow for the collection and analysis of data to be done in-field, with all calculations completed automatically requiring no post-processing. These rapid methods and standardized applications promote monitoring due to the relative low effort and time required. Importantly, they provide wetland mangers with needed information to refine management practices, while contributing data to regional habitat objectives, allowing conservation planners to most accurately step-down energetic goals.

Poster-58

Use of Intracoelomic GPS/GSM Transmitters in Mallards and Pintails: An Interim Look at Performance and Expectations

Presented by: Mike Szymanski (mszymanski@nd.gov)

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Technological capabilities used for wildlife tracking have grown exponentially in recent years, particularly for avian research applications. Beginning in 2018, the North Dakota Game and Fish Department initiated a project marking mallards to answer long-standing questions that were formerly cost-prohibitive or simply unattainable due to limitations by available transmitter packages. While most contemporary research projects are using GPS/GSM backpacks with harnesses, we opted to use surgically implanted transmitters, recognizing trade-offs associated with internal, non-rechargeable batteries. Our work began with marking pre-fledged mallards (Anas platyrhynchos) to gain data related to habitat-use during the post-fledging period. Over the course of two late-summer banding periods, we marked 137 juvenile mallards with Ornitela 32g units, of which 93% connected to GSM and provided data. Given the success of this project and on-going concerns and uncertainty related to northern pintails (Anas acuta), we worked with Ornitela in 2021 to test and develop a smaller implantable unit. After a successful, small-scale test, we moved ahead with a full project to mark female pintails with Ornitela 25g implantable GPS/GSM transmitters in central North Dakota during preseason banding and during late winter in New Mexico at Bosque del Apache NWR. Some of our objectives are to: evaluate breeding site selection and timing, nesting probability and propensity, evaluate habitat use during pre- and post-breeding periods, and compare vital rates and movement information to those derived from banding data. To date, we have marked 119 pintails with all birds providing data, and plan to deploy >200 more units. Like most GSM studies, we have experienced long periods without successful transmission due to insufficient cellular coverage, thus limiting data recovery, possibly due to battery depletion prior to network reconnection. We continue to refine duty cycles to achieve 1-year longevity while meeting data collection needs throughout the year to meet study objectives.

Poster-59

Avian Use of Marsh Terraces in Coastal Louisiana

Presented by: Madelyn McFarland (mbm391@msstate.edu)

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Louisiana's coastal wetlands support millions of resident and migratory birds annually. Louisiana accounts for approximately half of the coastal wetlands in the conterminous United States but, by some estimates, accounts for 80% of the nation's coastal wetland loss. At this rate of loss, Louisiana's coast may be incapable of supporting historically large populations of migratory and resident birds. Marsh terracing is a common restoration technique that uses in situ sediment to construct segmented ridges in open water areas to enhance marsh conditions, subsequently re-establishing vegetation that benefits wetland-estuarine dependent fauna. Despite widespread use, their value as avian habitat has received limited study. Using both ground and aerial surveys, we evaluated avian use of marsh terraces across 24-paired sites (terraced and adjacent non-terraced sites) in coastal Louisiana. Avian surveys focused on breeding secretive marsh birds (SMB) and wintering waterfowl. Results indicate that presence or absence of marsh terraces influenced numbers of ducks detected, though relative abundance varied spatially and temporally. Preliminary results of the SMB analysis reveal that non-terraced sites were used by a greater abundance and diversity of SMBs than terraced sites, though analysis is ongoing. We suspect that site-specific characteristics and two catastrophic hurricanes that occurred during our study likely influenced observed patterns of avian use of paired sites. Our study will better inform decisions on restoration techniques used to minimize marsh loss and improve avian habitat availability at local and regional scales.

Poster-60

A Statewide Survey of California's Breeding Redheads to Guide Conservation, 2017-2020

Presented by: Cliff Feldheim (cfeldheim@ducks.org)

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California’s breeding Redheads are currently considered a Species of Special Concern. No comprehensive survey has been conducted to identify where Redheads are nesting in the state and which areas should be targeted for conservation actions to promote breeding Redheads. We reviewed birding list serves from throughout the state, eBird, and historical and recent publications to determine locations to conduct ground surveys for breeding Redheads in 51 of California’s 58 counties between 2017-2020. During the breeding season, multiple surveys were conducted at 273 locations. This effort represents the most comprehensive approach ever implemented to survey breeding Redheads across the entire state. Between 336 and 900 Redheads were counted across the state annually. During the survey period, Redheads were absent or in very low numbers (<5) during the vast majority of surveys. Four counties produced 78% - 89% of all the Redheads annually. We identified four primary locations and four secondary locations to focus conservation efforts. In general, California’s Intermountain West region from Kern County to the Klamath Basin had low (less than 20) but consistent numbers of breeding Redheads and our data indicate that this region should be the focus of immediate conservation actions to ensure the persistence of breeding Redheads in California.

Poster-61

Rangelands: Working Lands for Waterfowl and Other Wildlife

Presented by: Josh Vest (josh_vest@fws.gov)

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The future of many waterfowl populations is intrinsically linked with the conservation and management of North American rangelands. Within the Central and Pacific flyways, the importance of rangeland management and sustainable grazing economies has become increasingly recognized to meet waterfowl habitat conservation goals. In many regions, rangelands support some of the most intact and functional wetland habitats remaining. Rangelands provide quality upland nesting cover and wetlands provide vital breeding habitat for waterfowl while providing sources of water and forage for livestock. Rangeland wetlands also provide vital foraging habitat for waterfowl during migration. Throughout the flyways, stock ponds developed for livestock water provide breeding, migration, and wintering habitat, especially in times of water scarcity. In landscapes dominated by agricultural production, rangelands provide some of the highest value ecosystem services including water quality, wetland function, and large carbon stocks that are maintained across the vast rangelands of North America. Recent research has shown livestock grazing, if managed properly, is compatible with and can be beneficial to providing quality waterfowl habitats. However, rangelands face considerable threats including cropland expansion, other land and water-use changes, and interrelated climate impacts. Here we provide regional examples of rangeland management, their importance to waterfowl and working-lands conservation partnerships aimed at sustainable ranching and wildlife goals. Rangeland and waterfowl managers will benefit from increased collaboration to aid in meeting common goals for healthy ranching communities, waterfowl populations, and other priority species such as grassland birds, sage grouse, and big game. A key to sustaining the array of socioeconomic and ecosystem services that rangelands provide will be collaborations with grassland-based agricultural producers to find solutions to the current economic disparity of rangelands relative to other uses such as cropland.

Poster-62

Insights and Observations of Emperor Goose (Anser canagicus) Broods Using Harness Transmitters on the Yukon Delta NWR, AK

Presented by: Mairin Murphy (mamurphy@uwsp.edu)

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In waterfowl, the time period between hatch and independence from adults is often difficult to study due to constraints in the ability to tag or observe precocial young while they travel and learn from their parents. This time period has been especially difficult to study in Emperor Geese (Anser canagicus) due to their unknown range of post hatch dispersal, high gosling mortality, and endemism to arctic ecosystems in Alaska and Russia. With decreasing sea ice levels and more extreme climatic events such as flooding and storms, it is imperative to factors that influence juvenile recruitment and behavior of Emperor Geese, particularly given that their current population status is near the management objective threshold for closing harvest. Previous studies on Emperor Goose movements have used spatially coarse light-level geolocation data or surgically implanted transmitters, however, for this study we tested a trial harness attachment method (e.g., external backpacks) to collect fine spatial data for examining natal dispersal. Preliminary results from 2022 indicate the mean seasonal home range area was 3.04 km2during the period between hatching a nest and initiating autumn migration off the Yukon Delta. Most of the home range being centered around large mudflat habitat to the north and east of the nesting area. These findings of mudflat use are contrary to previous studies centered around grazing lawn habitat. Continued analysis for 2023 includes behavioral observations to gain further knowledge of resource use.

Poster-63

Atlantic Brant Upland Habitat Use and Bioenergetics on Wintering Grounds

Presented by: David Weber (djweber@udel.edu)

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Atlantic brant (Branta bernicla hrota) populations are one of the least abundant game waterfowl species in North America. After a steep decline in eelgrass (Zostera marina) abundance during the 1930s on Atlantic Flyway wintering grounds, brant have partially switched to feeding on upland grasses (e.g. parks and golf courses) in many areas. Relatively little is known about habitat use in these upland habitats and how these upland habitats contribute to energetic needs of wintering brant. To better understand the wintering habitat needs as well as bioenergetic carrying capacity across the full use of available habitats, 230 individuals were marked with Ornitela GPS-GSM-ACC backpack telemetry units in New Jersey and New York. We have estimated wintering brant home range, daily movements, and habitat use using GPS data, with a particular focus on upland field use. We also have estimated daily energy expenditure using time-activity budgets derived from accelerometry data, with a particular emphasis on refining flight and nocturnal energy expenditure estimates. To assess upland field use and selection, we sampled upland turfgrass fields used by telemetered brant and unused fields within an individual bird's monthly home range. Turfgrass samples were analyzed to determine caloric or nutritional differences between used and unused fields that may be influencing field selection. We are combining the above information into a wintering habitat carrying capacity model for Atlantic brant; and will further discuss what drives upland field use and selection, and determine the importance of upland turfgrass fields for wintering brant.

Poster-64

A Global Comparison of Migration Strategies of an Arctic-Nesting Bird

Presented by: Amy Shipley (amy.shipley@wisconsin.gov)

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Migratory birds face a number of challenges during migration, such as flying long distances over open water or mountain ranges, and use a variety of strategies to overcome these challenges. While much work has been done across species to understand differences in migratory strategies, a gap still exists in our knowledge of intraspecific flexibility in migratory strategies when faced with starkly different challenges. We used data collected from GPS transmitters to quantify the number and duration of stopovers for 209 individuals representing seven populations of the globally-distributed Greater White-fronted Goose (Anser albifrons). Individuals among populations varied widely in distance traveled during migration (3,000-6,000 km). We found that migratory strategies were most similar among populations that traversed similar environments, e.g., across open water or across land. Populations that migrated over open water used fewer stopovers and stayed at them longer, while populations that migrated over land had many brief stopovers. However, the proportion of time that was spent at stopover sites was largely the same across populations. These results indicate that within a species, birds may be able to modulate time spent at stopovers to compensate for reduced opportunities for refueling. Consequently, species or populations that migrate over water and have fewer stopover opportunities may be most vulnerable to land-use and climate change due to the increased importance of individual stopover sites and the increasing variability in timing of green-up and food availability.

Poster-65

Winter Habitat Use of Canvasback in California

Presented by: Laurie Hall (lahall@usgs.gov)

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The San Francisco Bay Delta and Central Valley of California are integral wintering areas for several waterfowl species, including more than 50% of canvasback (Aythya valisineria) in the Pacific Flyway. Little is known about wintering habitat use of diving ducks in California, but this information is critical given on-going and projected habitat changes in the region. We evaluated winter use of wetland habitats in California by canvasback to identify management regimes that may benefit the species. We collected 26,247 locations during the winters of 2017, 2018, and 2019 from 49 adult canvasback fitted with GPS-GSM tracking devices. We examined habitat use with an ensemble modeling approach comprised of generalized additive models, random forests, and boosted regression trees. Our results suggested that habitat use differed among years; for example, in the wetter winter of 2017 canvasback had limited use of estuarine habitats (particularly in the Suisun region), with individuals moving inland to the Central Valley in early winter, potentially due to historic freshwater availability. In contrast, canvasback used several types of estuarine habitats in the drier winter of 2018, including shallow shoals, tidal marshes, managed marshes, and static deep-water ponds. Then, they transitioned inland towards freshwater habitats during spring months. Given cyclical drought conditions, planned tidal wetland restoration, and diminishing freshwater flows to the San Francisco Bay Delta, information on winter habitat use of diving ducks in California can improve our understanding of how projected habitat changes may influence these species in the future.

Poster-66

Ducks and Submersed Aquatic Vegetation Respond Positively After Invasive Carp Exclusion

Presented by: Vanessa Harriman (v_harriman@ducks.ca)

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Invasive carp can negatively affect waterbirds through habitat degradation, including removal of submersed aquatic veg¬etation (SAV). At a freshwater coastal marsh of great ecological and cultural significance, we excluded invasive common carp (Cyprinus carpio) with the goal of restoring the marsh to historical conditions to support fall-migrating waterfowl. We used a multi-pronged approach to assess the response of ducks and SAV to carp exclusion by leveraging historical duck and SAV surveys and collecting new data for six years post-exclusion on density and distribution of ducks within the marsh and SAV response. We found that fall-migrating duck numbers and total SAV extent rebounded to historical levels (1970s). There was a 339% increase in diving duck density and a nearly 400% increase in dabbling duck density between the pre- (i.e., 2000s) and post-exclusion periods. Diving ducks were more likely to be observed associated with SAV within the marsh, whereas dabbling ducks responded to emergent vegetation extent and water levels. Some aspects of the marsh recovery remain in question, including possible shifts in SAV community composition. Overall, the carp exclusion has successfully improved the quality of habitat for migrating ducks.